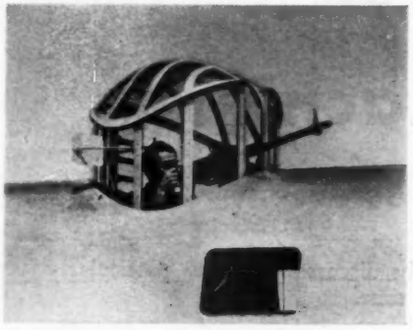
AMERICAN MACHINIST

September 3, 1941



Air Gunner—*Fighters aloft must have the best of planes and guns; but these are of little use unless ammunition of like quality is available in large quantities*

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SHOW-IN-PRINT—Picturing and describing what's new at the Annual National Metals Exposition in Philadelphia, October 20-24.

LIST OF EXHIBITORS—And other data about this Show, giving you your personal Preview, Guide & Record.

ALTERNATES FOR PRIORITY MATERIALS—Twelfth of *American Machinist's* famous "blue sections" on The Working of Materials, this one details selection, forming, fabricating, machining and finishing of materials available for non-defense manufacture.

WELDING A GUN CARRIAGE; HEAT-TREATING MACHINE-GUN PARTS—Twenty-ninth of *American Machinist's* special Armament Sections, this two-part study discusses subjects particularly pertinent at Show time.

THE HEAT-TREATING FURNACE AS A MACHINE — In modern Metal-Working, heat-treating is another one of the steps on the production line. Here's how it's done.

FURNACE BRAZING—During the past few years, this process has become increasingly important. Here's a summary of practice at one large company.

FLAME HARDENING—Another unit of the 15-part article by J. G. Magrath of Air Reduction Sales Co., well-known authority on this recently-developed process.

AND REGULAR DEPARTMENTS, NEWS, SPECIALIZED FEATURES

WHAT'S IN THIS ISSUE

CAL. 0.50 CARTRIDGES

This has been called a machine gun war. Fighting planes and tanks are equipped with large numbers of machine guns which require prodigious amounts of ammunition. Until new plants are completed, the U. S. air force is relying upon the Frankford arsenal for machine gun ammunition. It is produced here in one of the world's finest plants, the production line serving as a model for private manufacturers to follow. In our Armament Section, beginning on page 859, we describe the making of the cal. 0.50 cartridge, which involves 176 separate steps, at Frankford. Never before has this process been given in such minute detail. It should be of interest to innumerable metal-working shops engaged in defense work.

CHROME PLATING MOLDS

Molds for glassware are subjected to high temperatures for long periods and to severe friction because of the high speeds at which the glassware is pressed or blown on automatic machinery. An improvement has been made, however, since chrome-plated Meehanite molds were used. The molds now have a longer life and produce a better piece than previous molds. For the complete story, turn to page 854.

SHELL INSPECTION—1941 METHOD

Back in 1917 gages for shell inspection were almost worth their weight in gold. The procedure then was pretty cumbersome and involved doing a lot of things. Not so today. A five-man team using modern gaging equipment will now inspect 5,000 shell bodies in an eight-hour day (twice as many as under the old system) with greater accuracy and less fatigue. The way it's done now is described on page 874.

RIGHT MAN FOR THE JOB

Picking the right man for the job is one of management's tasks which causes plenty of headaches. With factory personnel expanding by leaps and bounds today, a workable method of measuring an applicant's worth can be invaluable. That's why mechanical aptitude tests have come into prominence. By their employment you often can determine whether a man is fitted for a particular job or not. Few people have had so much experience with mechanical aptitude tests as Dr. Richard Schultz of the Psychological Corporation. In the leading article in this issue (turn to page 845) he tells the merits of these tests and gives you an insight into how they work. To illustrate: Today one

Kaiden-Keystone

DR. RICHARD SCHULTZ

out of three applicants, regardless of experience, is suitable for training in machine or mechanical work. Aptitude tests quickly locate this man. Dr. Schultz explains the technique of using these tests in his article beginning on page 845.

LATHE HINTS

How can the lathe operator do his job better? There are many ways; and if he has a yearn to get along and some day win promotion, he will take every opportunity to improve upon his present efficiency. On page 887 are a number of hints for him, which he should not overlook. They will tell him fundamentals and also tricks of the trade which will stand him in good stead.

NITRIDING STEELS

Special steels suitable for nitriding now are being produced. They are known as Nitralloy. How to work these nitriding steels in the shop is the subject of one of our now-famous "Blue" materials sections starting on page 875 (you can always easily identify these sections because they are printed on blue paper). Bill Hargest, associate editor, devoted weeks to finding out everything that could be found out about nitriding steels from companies all over the country and then condensed the data into twelve information-packed pages. Included in the topics discussed are the preparation for nitriding, welding, equipment for nitriding, the nitriding process itself, the operations after nitriding and machining. You will find a number of useful tables too. You'd better save this section, because it is source material much of which you won't get elsewhere.

HARDENING CAST IRON

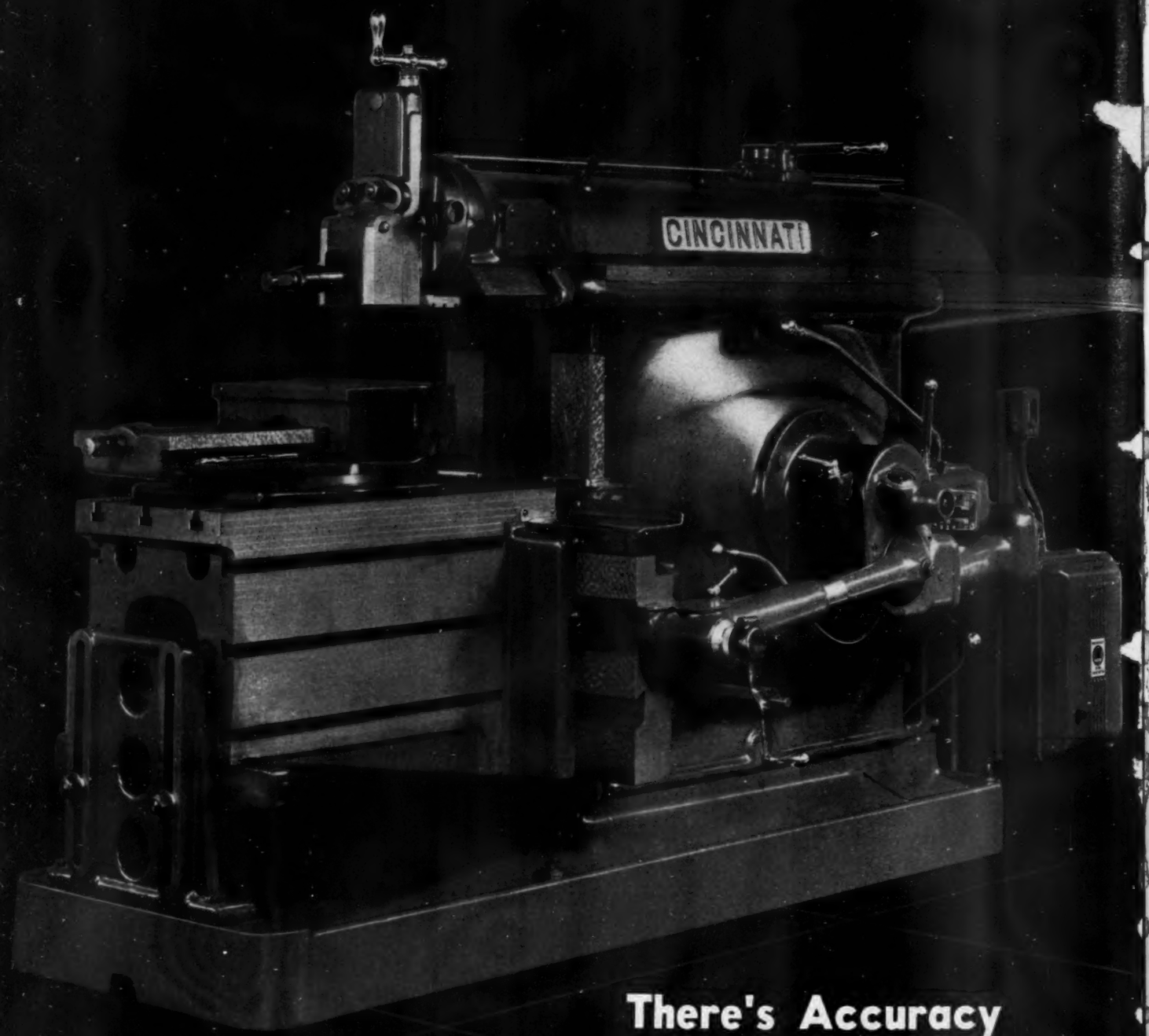
In his last installment on oxyacetylene flame hardening, J. G. Magrath, Applied Engineering Division, Air Reduction Company, explained that this process applies to cast steel and iron as well as to the forged and rolled varieties of steel. Now he tells of the influence on flame hardening of various percentages of alloying elements in cast iron. Mr. Magrath follows the style set in previous chapters—he gives the basic principles of the process and then illustrates the technique with examples selected from successful applications. Read the sixth part of this series on page 849.

COMING

Plating and painting aircraft engine parts is no mean task. It isn't something that is done as an afterthought. It is just as important as machining. How the work is carried out at Wright Aeronautical Corporation is described in a well-illustrated article in a forthcoming issue of AMERICAN MACHINIST.

Another feature soon to be published is a description of the machining of the Allison aircraft engine. This work is done at the Indianapolis plant where General Motors engineers have labored to good advantage to set up the best possible method of manufacturing an intricate, precise product. An AMERICAN MACHINIST editor spent several days getting the lowdown for our readers.

James G. Derck has invented a set of V-blocks and attachments from which a dividing head, a circular drilling fixture and several universal drill jig set-ups can be made. Many other time-saving set-ups can be produced from this set for tool and die work. These blocks and attachments, in fact, are applicable to many jobs which otherwise would require specially made jigs or more expensive equipment. A description of the set and what can be done with it will appear in an early issue.



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ESTABLISHED 1877 **AMERICAN MACHINIST** BURNHAM FINNEY, Editor

Measurement of Mechanical Aptitude

BY RICHARD SCHULTZ, THE PSYCHOLOGICAL CORPORATION

Employers look for men who learn quickly, have a capacity to do the work required. Many concerns have used aptitude tests to select their personnel

TODAY PRODUCTION EXECUTIVES and plant superintendents are much concerned with the problem of quickly finding and training men for specific jobs. During 1941 some four million additional workers will be needed to carry out the defense production program. About 38 percent of these new workers must be trained for skilled jobs.

This situation may be illustrated by the comments of a plant superintendent and personnel officer: "We have hundreds of men applying for work. Many of them have had no experience that would justify their employment. They probably have not learned how to work. Our biggest problem is to determine whether or not we can safely use them on production in the operation of even the simplest machines." Another organization observed applicants standing at the gate and found their conversation while waiting to be interviewed as follows: "The man asks us one or two questions and tells us there is no work. Many days we stand around for several hours. We don't know how he is able to pick his men. Some of us who have had experience won't go back to the plant. We don't think they are interested in experienced men."

The present shortage of labor may be eased by giving some consideration to the following procedures:

1. Select and assign men to do specific jobs at the maximum level of their ability and experience. For example, a man with no experience and good machine aptitude may quickly learn how to operate a drill press. But a man with some mechanical or trade experience and excellent machine aptitude may be encouraged to take special training that will eventually fit him for the more complicated work of operating a turret lathe. The applicant with little experience and only fair machine or mechanical aptitude will be quite useful on the more simple bench or machine operations.

2. Do not limit the search for machinists and mechanics to only those who claim interest or have had experience in this field. Aptitude tests have shown that a great supply of men suitable for training in machine and mechanical work may be found among such occupational groups as office workers, truck drivers, salesmen, gas station attendants. Age or education may be quite misleading. One organization in the metal trades found that over 50 percent of the employees had never considered machine or mechanical work before their employment with that company. Yet within a few weeks some of these men were able to turn out satisfactory production on simple machines. Within a period of six months many of the men were doing precision lathe work and some had been promoted to jobs as assistant foremen.

A lot can be done in the culling of applicants for employment in the machine and mechanical trades. A test of machine aptitude was given to 729 applicants, in a company manufacturing aviation equipment, over a period of more than three years. As might be

CHART 1

Flow Chart for Rapid Selection of Learners and Men with Experience for Machine and Mechanical Work

1. PRELIMINARY INTERVIEW
2. QUALIFYING EXAMINATION (15 minutes)
3. SPECIAL TESTS FOR APPLICANTS WHO PASS QUALIFYING EXAMINATION

NO EXPERIENCE	*EXPERIENCED*	*SKILLED AND TECHNICAL*
Machinist test (*15 minutes*)	Trade ability test (*10 minutes*)	Technical intelligence
Hand tool dexterity (*5–10 minutes*)	Measurement ability test (*10 minutes*)	Spatial relations test
		Special tests

CHART II

Outline of Job Tests for Rapid Selection of Learners and Men With Experience for Machine and Mechanical work

	Test	*Purpose*	*Method*	*Comments*
1.	Qualifying examination	To measure practical and general intelligence essential for adaptability and versatility in machine and mechanical work and other trades in the metal industry.	Applicant underlines answers to 40 questions. No time limit. Most men complete form in about 10 minutes.	Critical employment test for all applicants.
2.	Trade ability	To measure information and practice in trade for which applicant claims experience. Test is designed to quickly separate "bluffers", limited experience, semi-skilled and skilled men.	Applicant underlines answers to 20 questions on trade for which he claims experience. No time limit. Men complete form in less than 10 minutes.	Tests include trades such as: Drill press operator, gear cutter, precision grinder, lathe operator, bench hand machinist, general machinist, milling machine operator, radial drill operator, and toolmaker, etc.
3.	Measurement ability test	To measure ability to use precision instruments such as calipers, gages, and protractors.	Applicant underlines answers to 40 questions covering use and practice with precision instruments. No time limit. Men complete form in 10 minutes.	This test should quickly distinguish experienced and skilled men.
4.	Machinist coordination test:			
	A. Two hand coordination test	To measure ability to coordinate hands and eyes quickly and accurately. Essential for machinists.	Apparatus. Requires less than 15 minutes.	This test has been found to be a critical instrument in determining the neuromuscular flexibility and adaptability of experienced and nonexperienced men. Skilled mechanics demonstrate their ability very readily on this test. Semi-skilled machinists or those with little experience score much lower. Learners or inexperienced men who are most adaptable for automatic as well as other types of machines are readily identified.
	B. Controlled coordintion test	To obtain a measure of ability to coordinate hands and eyes quickly and accurately, in simple and automatic machine work.	Apparatus. Requires about 5–10 minutes.	This test is mounted as a drill press operation. It is particularly useful for learners and men who may be assigned to repetitive or automatic machine operations. This test is critical for experienced and inexperienced men. It is also a test that can be used in employing women for repetitive and automatic machine operations.
5.	Hand-tool dexterity test	To measure abilities for use of simple tool and hand dexterity.	Apparatus. 5–10 minutes.	A dependable measure of ability for assembly, bench work, and simple mechanical work.
6.	Arithmetical ability	To measure ability to perform arithmetical functions and other operations common in making practical computations in machine and mechanical work.	Paper form. 15 minutes time limit.	This test, in combination with the qualifying examination, is diagnostic for semi-skilled and skilled men.
7.	Visual-spatial ability test	To measure ability to think quickly and accurately in "visual-spatial relations".	Paper form. 14 minutes time limit.	It is critical as a test which grades off skilled machinists, mechanics, engineers, draftsmen, assemblers, assembly inspectors, drafting room checkers, and learners and eliminates unskilled and inferior abilities in these occupations.
8.	Technical intelligence	To obtain a measure of ability in dealing with fairly complex problems related to machine, mechanical and engineering work.	Paper form. Requires about 30 minutes.	This test is valuable with superior high school graduates for trade and apprentice training. It is also critical in grading off engineering graduates, draftsmen, and first class machinists and mechanics. It is a particularly useful test in selecting men for complex assembly and inspection work.

expected in a period of increasing production, applicants with good and even average ability have found employment. In January 1938, 30 per cent of the applicants tested were found to have good ability and 40 per cent had average ability, but by February 1941 only 9 per cent of applicants had good ability and 22 per cent average ability. The indication is that the quality of the labor supply has changed. By combining the percentages of applicants with good and average ability, it is estimated that today at least one out of every three applicants, irrespective of experience, is suitable for training in machine or mechanical work. Aptitude tests quickly locate this man.

How Tests Are Made

The illustrations that follow show selection methods that are being used in some companies in meeting today's needs for skilled men. Chart I is a flow chart illustrating a method of using selection tests in the regular employment procedure for different grades of work. The general manager of a company states: "As a means of weeding out the untrainables, our aptitude tests have worked out just about 85 per cent.

Chart II contains a brief description of tests which have been developed especially for selecting men for machine and mechanical work.

Chart III shows some of the questions used in the qualifying examination referred to in Charts I and II. These questions are negligibly influenced by previous experience and for practical purposes grade off men in a simple classification, as follows:

(a) Men suitable for training as first class machinists or mechanics.

(b) Men suitable for training as semi-skilled machinists, or mechanics.

(c) Men suitable for training on very simple machines or bench work (simple assembly, filing, inspection).

(d) Men suited for unskilled work.

(e) Men doubtful for employment on work requiring even simple use of tools or machinery.

With the adult type of machinist or mechanic claiming some experience on a special type of work, it is possible to find out within 10 minutes whether he is qualified. It is not necessary to talk at length to a man with varied experience in order to find out whether he is able to handle a certain job. Instead merely give him a form consisting of 20 questions as illustrated for lathe work in Chart IV. This method quickly separates men as follows: bluffers, those with limited experience, semi-skilled and skilled workers.

In addition to this simple trade ability test for men with some machine or mechanical experience the Measure-

CHART III

Sample Questions of a Qualifying Examination

NOTICE HOW YOU ARE TO MARK THE ANSWERS

You are to underline the ONE and only one answer which you think is right for each question. If you are not certain which answer is right, underline the ONE you think best.

SAMPLE: A MICROMETER IS USED FOR:
smoothing threading clamping measuring

The correct answer to this question is measuring, so measuring is underlined.

DO OTHERS IN THE SAME WAY

BEGIN HERE

1. A BLOCK AND TACKLE IS USED TO:
tie boxes together — make lifting easier
operate machines faster — keep belts on pulleys

11. AN ALLOY IS:
non-metallic substance in metal — mixture of metals
pure metal — steel without carbon

14. A RHEOSTAT IS USED TO:
measure regulate generate transform

17. AN AUGER BIT IS USED FOR:
drilling holes in metal — drilling holes in wood
broaching — removing burr

CHART IV

Sample Questions of a Lathe Trade Information Test

NOTICE HOW YOU ARE TO MARK THE ANSWERS

You are to underline the ONE and only ONE best answer for each question. If you are not certain which answer is right, underline the ONE you think best.

SAMPLE 1: WHICH TOOL IS USED FOR MEASURING INSIDE DIAMETERS?
thread gage inside calipers gage blocks surface gage

The best answer is inside calipers, so it is underlined.

BEGIN HERE

1. HOW DO YOU POLISH TURNED WORK IN A LATHE?
file emery cloth blunt tool buffer

2. HOW IS A MACHINISTS' SCALE USUALLY DIVIDED?
1/64's 1/10's 1/100's centimeters

4. WHERE IS THE LIVE CENTER LOCATED ON A LATHE?
in the tail stock — on the carriage
in the head stock — in cone pulley

7. WHAT DO YOU DO TO CUT AN OUTSIDE TAPER IF THE LATHE HAS NO TAPER ATTACHMENT?
use a special chuck — increase the rake of the tool
throw over the tail stock — slow up speed of lathe

12. THE POINT OF THE LATHE CENTER FORMS AN ANGLE OF:
30° 90° 60° 45°

ment Ability Test illustrated in Chart V is used. The ability to handle precision instruments is an important specification in selection of men for this type of work.

In Chart II it was noted that pencil and paper tests were given which measured the applicants information of the trade practice, and also measured one's ability to use precision instruments. The grade scores which applicants make on these tests may be correlated with performance in the shop. Hence those making the higher scores on the tests were found to do the best grade of work in the shop. Of course, it may be necessary to standardize the test for each company. In effect, this is to formulate a test which will measure a particular ability for which the company in question is looking. Hence without standardized test ratings the results would be meaningless, no valid or reliable conclusions could be derived therefrom. The percentage of men who fall into, say, group A (those doing excellent work), may necessarily vary for different companies and localities.

The methods outlined above show what is being done in some defense production industries in classifying applicants before employment for different types of work. This type of information when obtained by a company makes it possible to hire men immediately or to quickly call back certain applicants as they are needed.

These methods for hiring men do not in any way slow up the selection procedure but rather eliminate unnecessary errors. The immediate values in using more precise selection methods may be listed as follows:

(1) An audit is made of the abilities of the labor supply as it is available.

(2) A simple and practical classification is set up for all employees.

(3) A useful inventory of needs for training of men is automatically prepared for the company.

(4) It is a basis upon which men can be assigned immediately to production as specialists and may be further trained for up-grading or more difficult work on jobs requiring a higher degree of skill.

(5) Just as good production methods demand a continuous physical inventory of manufacturing and control, so an inventory on man power provides the key for insuring and controlling production schedules.

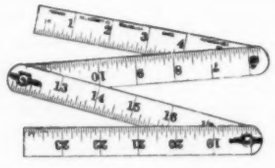
CHART V

Sample Questions of a Measurement Ability Test

READ INSTRUCTIONS CAREFULLY

HERE ARE SOME MEASURING INSTRUMENTS. LOOK THEM OVER CAREFULLY

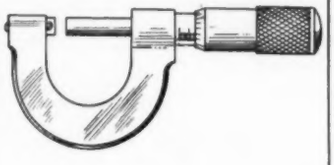
Underline the ONE correct answer to each question about each instrument.



SAMPLE: NAME: center gage level folding rule square

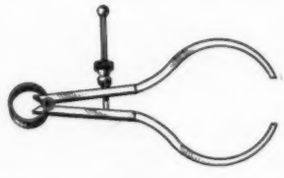
USE: to make a circle to measure length to determine smoothness

BEGIN HERE:

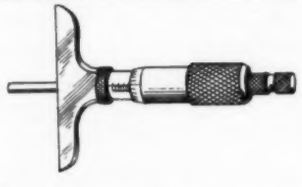


1. NAME: vernier caliper micrometer caliper protractor inside micrometer
2. USE: testing level of work
   measuring outside diameter
   measuring angles on work
3. When this instrument is equipped with a vernier, what part of an inch can be read correctly?

   .01 .0001 .1 .001



19. NAME: universal calipers inside calipers outside calipers compass
20. USE: to lay out work to measure diameter of holes
    to determine thickness of cylinder
21. What instrument can be used with this one to obtain a direct measure?
    micrometer calipers steel scale gear tooth caliper surface gage



24. NAME: surface gage bevel protractor micrometer depth gage vernier caliper
26. USE: locating central hole in work
    determining level of work
    measuring depth of hole

Alloy Cast Irons

COMPILED BY J. G. MAGRATH, APPLIED ENGINEERING DEPARTMENT, AIR REDUCTION COMPANY

The discussion of cast metals concludes with comments on the hardening of Meehanite, and malleable and gray cast irons

ALLOY CAST IRON is a cast iron which contains specially added elements in sufficient amounts to product a measurable modification of the physical properties of the iron in the section under consideration. Silicon, manganese, sulphur and phosphorus, as normally obtained from raw materials, are not considered as alloy additions,[13] although manganese has a special effect.

A number of alloy cast irons will respond satisfactorily to flame hardening. Advocates of the use of alloyed irons maintain that cast irons should contain as much of the "critical temperature lowering elements as practical with others reduced to essential or necessary amounts."[14]

It is claimed that when chromium, nickel, molybdenum or manganese are introduced to improve core characteristics, the hardness and depth will be benefited.

The alloys are offered by their various producers as contributing the following functions to cast irons in their "as cast" state:

CHROMIUM contributes directly to hardness in the direct ratio to the proportion used. Its addition up to 0.5 percent improves the tensile strength of gray irons of normal section and analysis. In heavier sections, chromium additions up to one percent, are frequently more effective. It serves to increase wear resistance.

COPPER provides increased wear resistance and generally increases the tensile strength. It increases the hardness in proportion, the amount and rate of increase depending upon the carbon and silicon content.

MANGANESE may act as a softener in quantities of less than one percent. It provides increased wear resistance and increased amounts will contribute to hardness in direct proportion to content. It has little effect on tensile strength in amounts less than one percent. In higher percentages there is gradually increasing effect.

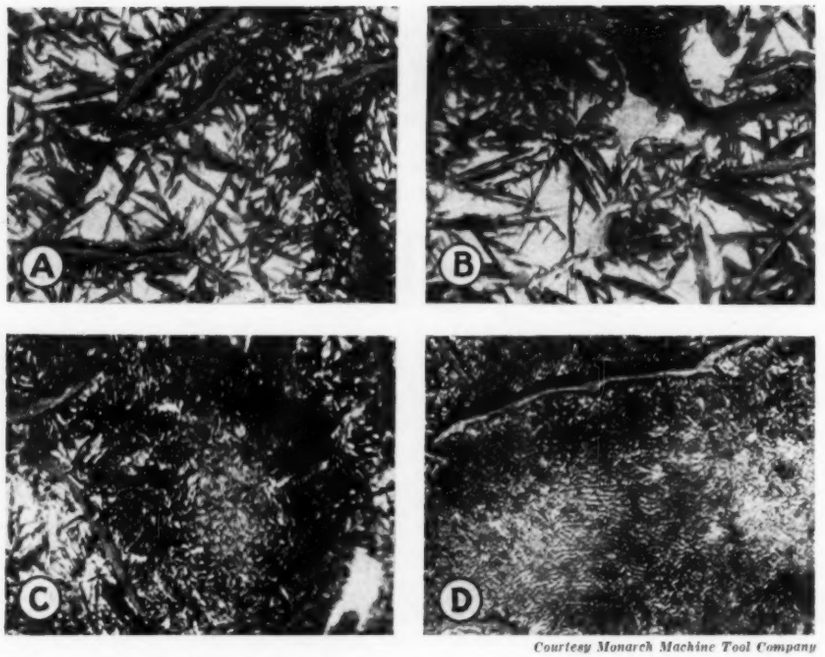
MOLYBDENUM additions tend to harden cast iron and improve the tenside strength. The improvement is progressive with increasing percentages of molybdenum. It is also used effectively in combination with other alloys to increase tensile strength. It provides improved wear resistance.

NICKEL is beneficial to hardness and to tensile strength under proper conditions in amounts up to four percent. It improves machinability. Nickel or nickel-chromium cast iron will develop

Table VII—ALLOY CAST IRONS

Classifications	ANALYSIS								BRINELL HARDNESS*	
	T.C.	Gr.C.	C.C.	Mn	Si	Cr	Ni	Mo	Before Flame Hardening	After Water Quench
Nickel	3.46	2.78	0.68	0.71	1.28		1.08		215	507
"	3.13			0.86	1.84		1.43			514
"	2.84			0.91	1.42		1.47			495
"	3.24			0.57	1.19		1.50			514
"	3.22			0.67	1.76		1.61			514
Nickel-Chromium	3.01	2.60	0.41	0.79	2.21	0.42	1.07			470
" "	2.95			0.81	1.67	0.33	1.28			514
" "	2.87			0.85	1.66	0.29	1.57		217	550
Chromium-Molybdenum	3.19	2.50	0.69	0.76	1.70	0.03		0.01	217	436
" "	3.19	2.57	0.62	0.81	2.28	0.37		0.23	187	525
" "	2.85	2.26	0.59	0.76	2.04	0.29		0.30	192	555
" "	3.22	2.57	0.65	0.75	1.73	0.03		0.47	223	555
"	3.20	2.62	0.58	0.64	1.76	0.01	Tr.	0.48	223	578
Nickel-Chrome-Moly	3.00			0.75	2.25	0.20	0.20	0.35	225	540
" " "	3.36	2.75	0.61	0.74	1.96	0.35	0.52	0.47	235	524
" " "	3.21	2.61	0.60	0.67	2.24	0.50	0.06	0.52	235	534
" " "	3.22	2.69	0.53	0.66	2.02	0.02	1.21	0.52	241	524

** Hardnesses as shown are not indicative of maximum hardness obtainable but are representative of flame hardening results using varying quenching rates to meet specific hardness specifications.*



Courtesy Monarch Machine Tool Company

Fig. 6—Alloy cast iron *flame-hardened structure is shown in the four accompanying microphotographs, at 500×, of the way surfaces of a Monarch lathe bed. The composition of this cast iron is:*

	Max. %	Min. %		Max. %	Min. %
T.C.	*3.20*	*2.80*	*Ni*	*1.50*	*1.00*
C.C.	*0.75*	*0.55*	*P*	*0.15*	*1.00*
Si	*2.00*	*1.70*	*S*	*0.10*	*1.00*
Mn	*1.00*	*0.70*	*Cr or Mo*	*0.25*	*1.00*

A. Microstructure of the area of greatest hardness with fine-grained martensitic structure.

B. Microstructure of the upper intermediate zone with definite areas of sorbite with slightly coarser martensite distribution.

C. Microstructure of the lower intermediate zone with areas of pearlite that are changing to martensite.

D. Microstructure of the unhardened zone with a normal pearlitic iron structure with long strings of graphite.

This iron is composed of a fine pearlitic matrix, interspersed with well distributed graphite flakes. The hardened surface has a full martensitic structure which gradually blends into the pearlite of the base metal so there is no definite line of demarcation which might cause chipping.

a particular depth of hardened layer with less heat and less hardening stress than will an unalloyed cast iron.[14] Generally nickel cast iron is less critical to flame hardening than other cast irons.

VANADIUM introduction of 0.10 percent to a plain cast iron of about 3.20 percent of carbon will raise the "as cast" hardness approximately 20 to 25 points Brinell. It tends to increase the tensile strength.

Table VII lists a number of successfully flame-hardened alloy cast irons, and Fig. 6 illustrates the microstructure of an alloy cast iron employed in making Monarch lathe beds.

The effect of alloys in cast iron on Brinell hardness and tensile strength on a given analysis cast iron, as charted by the American Foundrymen's Association, is shown in Fig. 7.[13] Different analyses may show different results, but those given for the particular analysis described, indicate a general trend.

MEEHANITE is a trade name applied to cast irons of a commercial analysis. It is described as a sorbo-pearlitic iron containing silicon, manganese, phosphorus, sulphur, carbon and certain alloys, its composition depending upon mixture and physical constitution as determined by service requirements. Twelve grades are available, all of which can be heat-treated, each having a separate and distinct combination of physical properties.

A number of the Meehanite irons have been flame hardened. Results on a number of these are shown in Table VIII. In general it has been observed that most grades of Meehanite are flame hardenable. Greater care is exercised in the application as compared to high-carbon steels to avoid burning or fusing the metal. As the span of temperature on Meehanite between the hardening and softening temperature of fusion is not large the flames must be moved sufficiently fast and correctly adjusted.

In making malleable iron, a "white iron" casting, in which the carbon is present in the combined form, is first produced. The casting is annealed or graphitized so that the final structure consists of ferrite and free carbon in the form of "temper carbon," with substantially no combined carbon in the form of free cemetite or pearlite. It is thus converted into a black-fracture, soft, machinable casting. Silicon, manganese, phosphorus and sulphur are present. The tensile strength decreases as the carbon increases.[13]

In flame hardening, best results are obtained on machined surfaces. Rough castings may be flame hardened successfully, but the decarburized surface areas will not readily respond to heat-treatment. When checking rough sections for hardness, the decarburized surface must be removed and the test made on the parent metal.[10]

Black-heat malleable iron may be successfully flame hardened by either heating and quenching or by the common progressive procedure. The first procedure provides greater control, as a martensitic structure and maximum

Table VIII—MEEHANITE IRONS

ANALYSIS							BRINELL HARDNESS*	
T.C.	Gr.C.	C.C.	Mn	Si	Cr	Ni	Before Flame Hardening	After Water Quench
2.65	0.56	2.09	0.63	1.01	0.24		367	518
2.77	2.08	0.69	0.91	1.82	0.10	0.16	253	472
2.88	1.92	0.96	0.72	1.42	0.11	Tr.	350	560
2.94	2.30	0.64	0.84	1.58	0.08	0.07	292	450
3.10	2.61	0.49	0.67	1.91	0.06		241	472

** Hardnesses as shown are not indicative of maximum hardness obtainable but are representative of flame hardening results using varying quenching rates to meet specific hardness specifications.*

Table IX—PEARLITIC MALLEABLE IRONS

ANALYSIS					BRINELL HARDNESS*
T.C.	Gr.C.	C.C.	Mn	Si	After Water Quench
2.30	1.80	0.50	0.95	0.98	401
2.65	2.15	0.50	0.40	1.25	525

** Hardnesses as shown are not indicative of maximum hardness obtainable but are representative of flame hardening results using varying quenching rates to meet specific hardness specifications.*

surface hardness is produced through heating at a rate that allows the temper carbon to diffuse as uniformly as possible through the matrix before quenching.[15] It is advisable to remove the decarburized surface skin to obtain best results. When the part serves its purpose best, however, with the "as cast" surface skin, choice can be exercised. A top surface hardness somewhat below the actual hardness beneath may result, but after a relatively small amount of wear, the hardest flame hardened zone is exposed and resistance to further wear correspondingly increased.

Recently processes have been developed whereby certain white irons are given special heat-treatments, which result in products that are ductile and contain some temper carbon and some combined carbon as pearlite or sorbite. Such are called "pearlitic malleable" irons.

They have a higher yield point and ultimate strength and lower elongation than normal malleable irons. They machine somewhat less readily because of the presence of combined carbon and have a higher indentation hardness.

Pearlitic mallable irons, because of the nature of the matrix, containing combined carbon of various contents, are readily flame hardened by either the heating and quenching or the progressive method, and produce a satisfactory martensitic structure.[15] Those with combined carbon content around 0.5 percent act somewhat the same as cast irons of similar combined carbon content.

Two flame-hardened pearlitic malleable irons are shown in Table IX.

In malleable irons only those alloying elements, ordinarily encountered in flame hardening, have so far proved of interest. These are as follows and are mentioned only to provide a full coverage of the subject rather than for any known value in flame hardening.

CHROMIUM—claimed that with proper adjustment of silicon content, chromium could be used to produce a product with higher strength and greater wear-resistance. Chromium acts to inhibit graphitization in malleable iron.

COPPER — claimed to accelerate graphitization, strengthen the ferrite and increase hardness through a precipitation effect by quenching from about 1300 F. followed by a tempering.

MOLYBDENUM—claimed to provide higher tensile strength and improved resistance to abrasion.

The next installment of this series will be found in an early number.

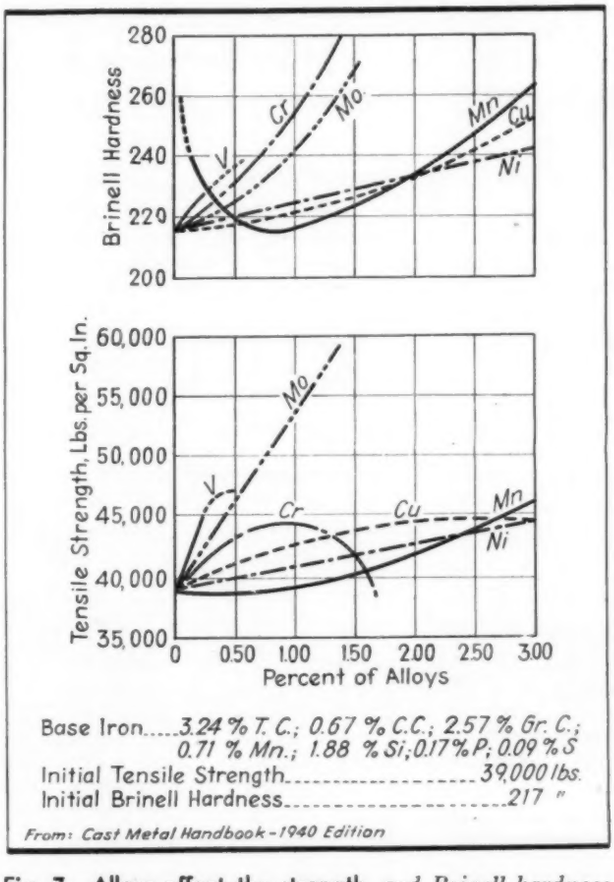


Fig. 7—Alloys affect the strength *and Brinell hardness of this particular cast iron as shown. For other analyses their influence may vary*

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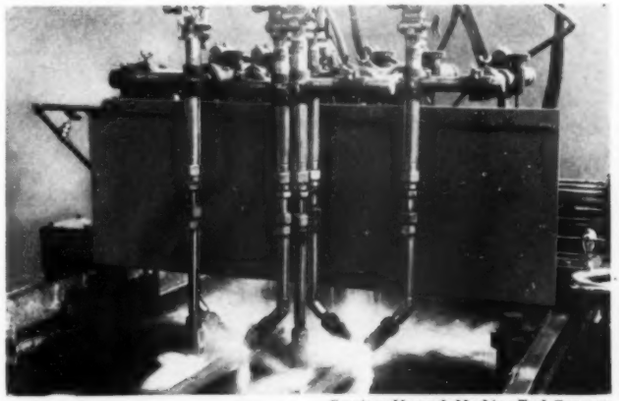
13. *Cast Metals Handbook*, American Foundrymen's Association, 1940
14. Flame Hardening of Cast Iron, by F. G. Sefing; *Iron Age*, October 19, 1939
15. Flame Hardening Malleable Iron, by Stephen Smith; American Foundrymen's Association Meeting, May 12, 1941



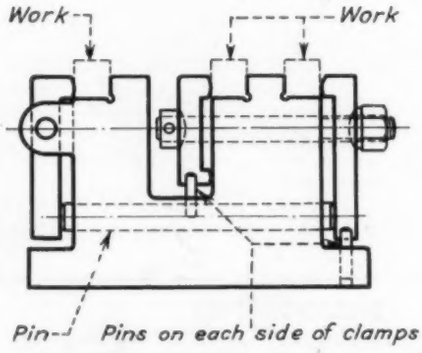
Courtesy Monarch Machine Tool Company

Lathe beds *are immersed up to the underside of their ways in a tank of continuously circulating cold water. Six surfaces, two V's and two flats, are flame hardened in one pass. Hardness penetration averages ⅛ in. The average distortion of an 8½-ft. bed is about 0.008 in. which is eliminated by grinding. Hardness of from 75 to 80 scleroscope is obtained in daily practice*

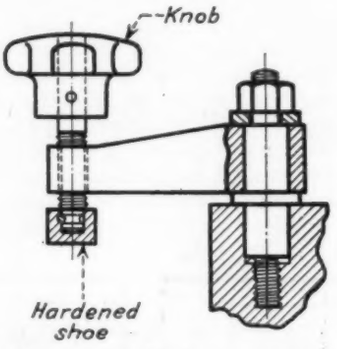
Work Clamping Devices—III

BY JOHN G. JERGENS, CLEVELAND PNEUMATIC TOOL COMPANY

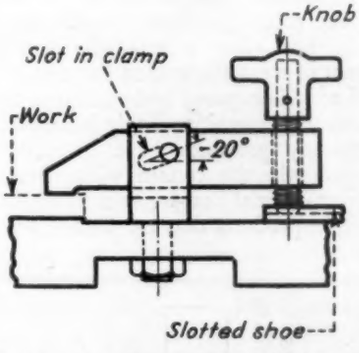
THE NINETEEN EXAMPLES of various clamping devices shown on these pages complete the present series. These examples will be found satisfactory for a wide variety of applications in jig and fixture design. A number of these devices can be assembled from standard parts which are interchangeable with other clamping arrangements. Where a large number of jigs and fixtures are to be made, it will prove economical to make up suitable quantities of certain of these units so that tool expense can be reduced. Wearing surfaces on these parts should be hardened.



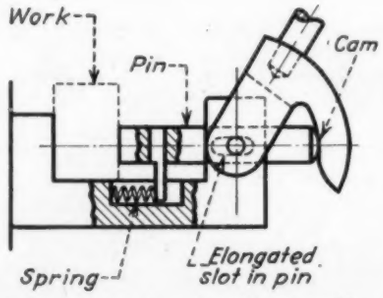
Single adjustment locks three pieces



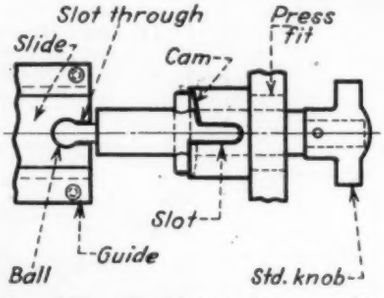
Swing clamp assembly has many uses



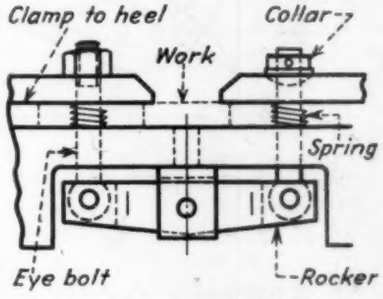
Quick rising clamp adjusted by screw



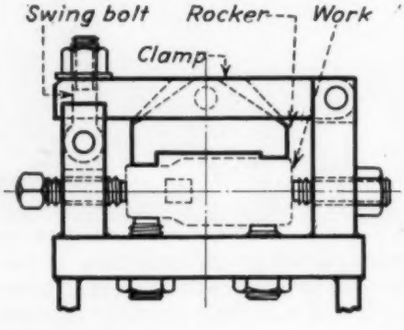
Spring returns clamp in this assembly



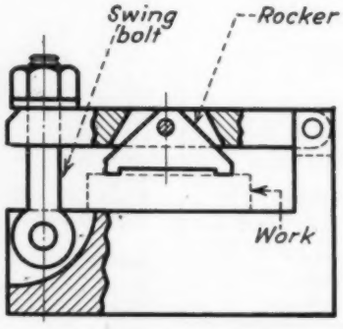
Face cam moves slide in this assembly



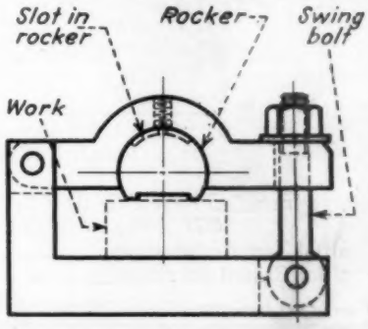
Rocker insures equal clamping



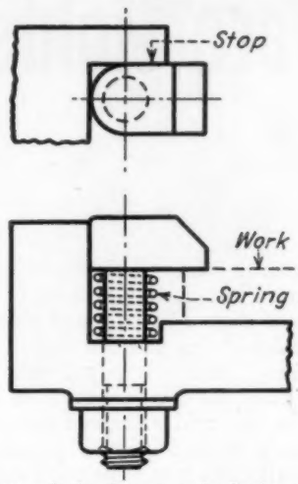
Rocker provides equal pressure on sides



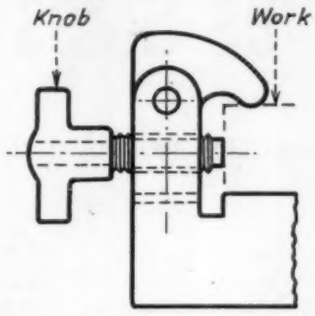
Simplified leaf-type clamp with rocker



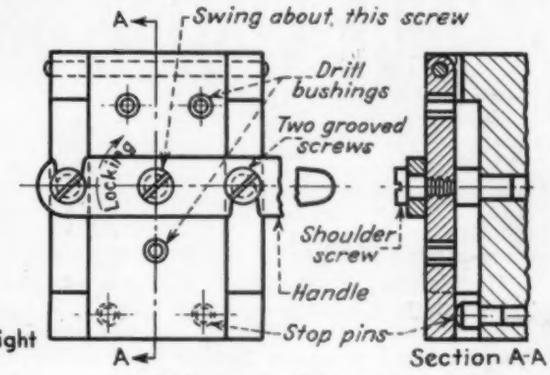
Clamps with special rockers are useful



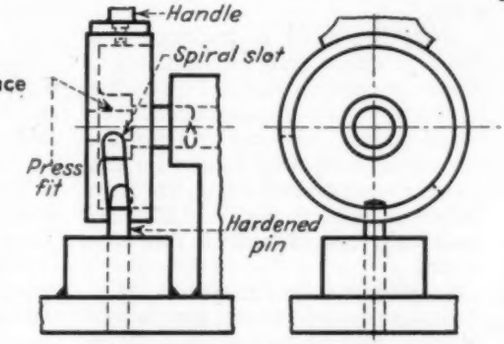
Swing-bolt clamps take little space



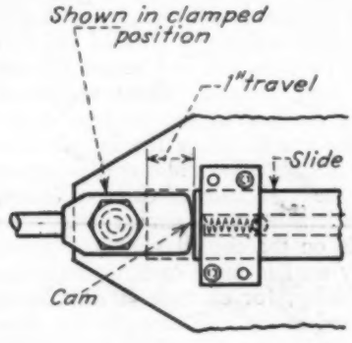
Double-acting clamp holds work tight

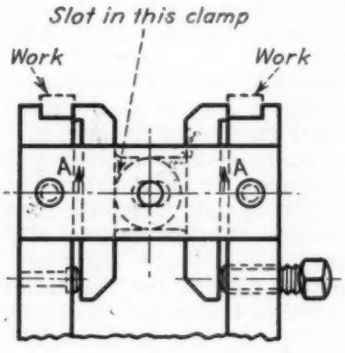


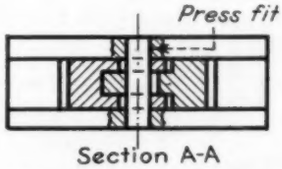
Swinging arm locks at each end



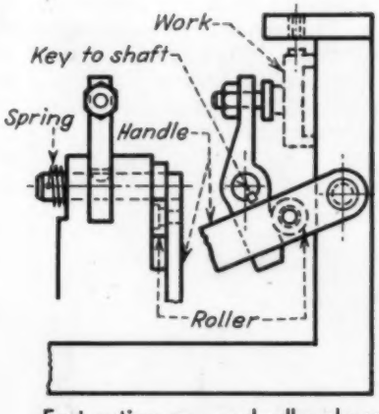
Barrel cam moves slide in this clamp



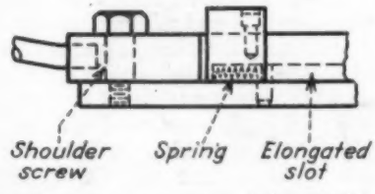




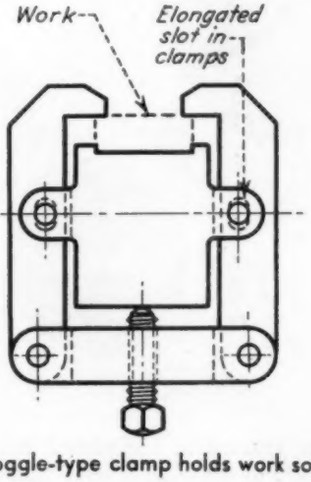
One screw locks two pieces



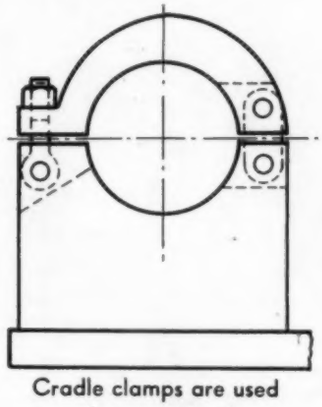
Fast-acting cam and roller clamp



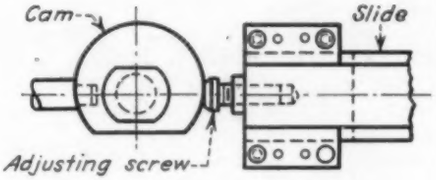
Simple plate cams move slides quickly

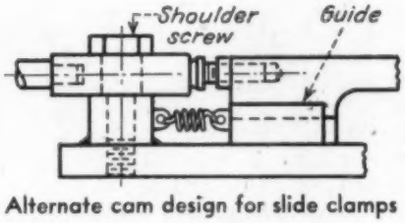


Toggle-type clamp holds work solidly



Cradle clamps are used for round work





Alternate cam design for slide clamps

Chrome Plating Saves Glassware Molds

BY D. McGREGOR, A.C.I. ENGINEERING PTY. LTD., AUSTRALIA

Chrome-plated Meehanite molds for pressing glassware have longer life and produce better work than did previous molds

THE HIGH SPEEDS at which glassware now is pressed, or blown, by automatic machinery subjects the mold units to high temperatures and severe friction for long periods. These sometimes cause thermal fatigue or heat cracks in the molds. Since the introduction of Meehanite for molds and plungers, and the application of chrome plating, considerable improvement has been made on the chilled gray iron previously used in mold construction.

Taking, for example, a dish being pressed at the rate of eight per minute, the temperature of the glass in the furnace proper is 2,850 F. and drops to somewhere about 2,800 F. on contacting the mold and plunger. In their unplated state, the plunger and molds tend to lose their high polish quickly and, after four hours' work, a heavy coating of oxide is formed on their surfaces. After working 30 hours the molds show distinct hair-like cracks which, in turn, show up on the glassware like those on an old oil painting. The molds in this state are useless and in the majority of cases have to be scrapped. On the other hand, chrome-plated molds and plungers retain their initial high polish; the life of the molds has been trebled and, in some cases, increased tenfold. In addition, the glass articles produced have a crystal-like luster which adds to their appearance and sales appeal.

It should be pointed out that the making of Pyrex glassware calls for a temperature of 2,850 F., while glass used for tumblers and other pressed tableware, known as *soda glass,* is pressed in the vicinity of 1,800 to 2,000 F. In consequence, mold equipment used for soda glass is good for many hundreds of working hours. As in the case of Pyrex ware, the use of chrome plating is responsible for a more brilliant article and allows thin walled pieces to be pressed which previously had to be blown. The low coefficient of friction of chromium allows the glass to flow smoothly up the narrow passage between the plunger and mold. The molds require replating only when damaged by cold, solidified glass. The plated deposit need only be a fraction of a thousandth of an inch thick.

After the mold is machined and hand processed, all file and emery marks are carefully polished off by felt buffs and a polishing compound. The plated surface is an exact replica of the face of the base metal below; for this reason a close grained metal, free from defects is essential. Chilled "E" Meehanite has helped achieve this condition.

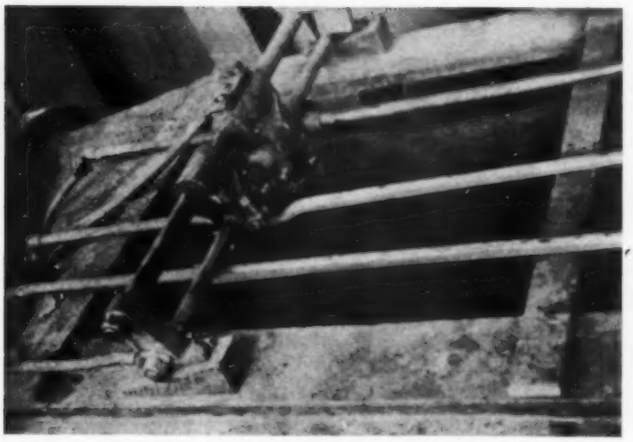
To prepare a lead anode shaped to the inner area to be plated, molten lead is poured into the back of the mold on the plunger. The resultant lead cast is the same shape and size as the glass article which the mold will eventually produce. This anode is peppered with $\frac{5}{16}$-in. diameter drilled holes to allow the chromic acid to circulate freely and prevent the formation of gas pockets in any deep depressions that may be in the mold.

The molds then go through a thorough cleansing process. The mold first is immersed in a boiling mixture of 4 oz. of metal cleaner per gallon of water, and remains in this bath for five minutes while 400 to 500 amp. at 5 volts is passed through. On removal, it is swirled in clear cold water, and scoured with finely ground pumice powder, using a soft cloth mop. The mold next is placed in a cast iron arm, or holder, and the whole is dipped again in clean cold water and then quickly into a ten per cent sulphuric acid bath. It is swirled again in cold water and finally placed in position in the plating bath proper.

Meanwhile, the lead anode has been attached to a cast iron arm, similar to the mold holder, and is, in turn, secured vertically downward to a bar running across the top and narrow way of the plating tank. The anode is now about one foot below the level of the chromic acid solution. The mold is placed in a position, in a like manner, on the same bar as the anode. This brings the mold and anode concentric to each other. The outer surface of the anode stands off about $\frac{1}{2}$ in. from the corresponding face of the mold. The

The Pyrex dish seen in the foreground was pressed in the plated mold, plunger and ring shown above. The temperature of the glass when removed from the furnace is about 2,850 F. Unplated molds lose their polish quickly in such operations

The cast iron mold holder and cast lead anode, drilled to allow plating solution to circulate, are suspended about ½ in. apart in tank



Although supported by same bar, so as to insure alignment, the work holder and lead anode are insulated from each other

anode and mold holders, although on the same bar, are insulated from each other. The positive lead is connected to the anode holder and the negative lead to the mold. The current which is supplied by a 500-amp. generator is switched on at 6 volts and held at 250 to 300 amp. for 20 min.

The chromic acid bath consists of 3 lb. of chromic acid plus 0.4 oz. of sulphuric acid to each gallon of water and is maintained at 80 F. by means of steam coils surrounding the lead lined steel tank. After switching off the current, the mold is removed from the bath and thoroughly hosed with cold water. The resultant plate is a smooth grey deposit which must be brought to a brilliant polish by buffing.

The plating of the plunger is done in the same way with the exception that a shaped anode rarely is required. The standard strip lead anodes of the regular plating bath usually suffice. When replating is called for, the original plated deposit must be completely removed. This is done in a stripping bath made up of caustic soda, the anode being arranged as in the plating operation, but with the current reversed. Twenty minutes' immersion is usually sufficient to strip off the old deposit. Of course, before replating, the mold is buffed and polished to the original high luster.

To obtain the best results, the required conditions may be summarized as follows:

1. The metal to be plated must be of good close grain and free from defects of any kind.

2. The surface must be highly polished and scrupulous care must be taken to remove grease or any other foreign matter. In the case of internal work, the anode must be kept equidistant at all points to the plated object.

3. The bath must be kept reasonably close to the solution mentioned. Constant checking with a hydrometer is advised. Finally, the tank must be as near 80 F. as possible.

Occasionally, when some portions of the mold are required to withstand severe friction, a deposit known as hard chrome is used. This is obtained by preparing the mold as before, and then plating in the same bath at 130 F. with the twice plating period. The deposit, in this case, is much heavier, being from two to three thousandths of an inch thick, and is so hard as to be unfileable. This plate has been applied to ring and plug gages made from Grade "B" Meehanite.

Big Surface Plate—*Pontiac production men are able to discover and correct errors in assembly before they become troublesome by using an 18x18 ft. surface plate. A full size chassis, a body or even a complete car may be checked in this way. The plate is kept level and is accurate to 0.005 in. over its full length and width*

IDEAS FROM PRACTICAL MEN

Tool Depth of Threads Easily Calculated

BY CHARLES MARTINETZ

The most convenient method of calculating tool travel when cutting 30-deg. threads was given by Laurence F. Southwick (*AM.* Vol. 85, page 702). This is use the formula $3/(4N)$, where N is the pitch. For a nine pitch thread, the tool travel is 3/(4x9) or

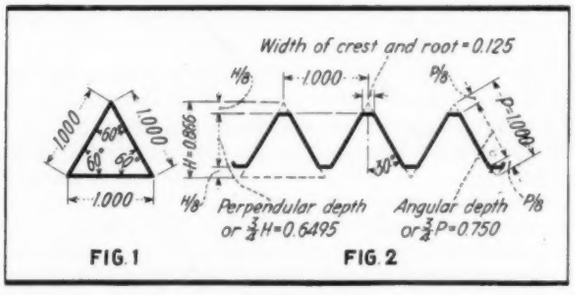


FIG. 1 FIG. 2

These constants divided by the pitch will give the dimensions of National Form threads, which includes the required tool travel for cutting them

0.0833 in. The perpendicular depth can be obtained, as Mr. Southwick pointed out, by multiplying this figure by 0.866, which gives 0.0721 in.

The writer has always used the method advocated by Mr. Southwick, but has expressed the formula as $0.750/N$, which gives the same results quoted above. Mr. Southwick showed how the formula was derived, but I believe it can be more clearly stated, and all dimensions for the thread more easily obtained.

For example, all calculations for the National Form of thread are derived from the equilateral triangle, where the base and sides are equal, as shown in Fig. 1. The constant for calculating the perpendicular depth of sharp V-threads is 0.866, while the constant for the 30-deg. angular depth is 1.000.

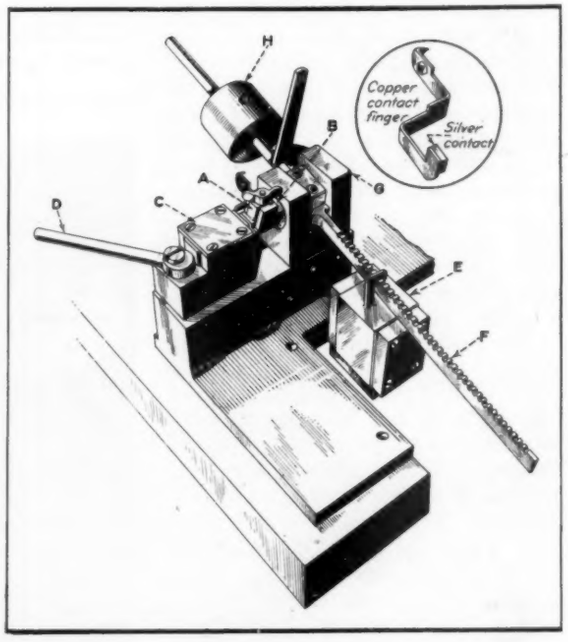
To obtain constants for the National Form of screw thread, one eighth is taken from the top and one eighth from the base of the equilateral triangle to form the crest and root of the thread. Therefore, as shown in Fig. 2, the constants for the perpendicular depth is 0.6495, while that for the angular depth is 0.750, and that for the width of the root and crest is 0.125. These constants, divided by the pitch of the thread, will give the perpendicular and angular depths, and widths of the crest and root, respectively. For example, with a nine-pitch thread the angular depth is 0.750/9 or 0.0833 in. The perpendicular depth is 0.6495/9 or 0.0721. The width of the crest and root is 0.125/9 or 0.0139.

If the position of the compound rest for cutting screw threads in a lathe is set at 29 deg., which many machinists claim to be superior to the 30-deg. angle, the constant for calculating the 29-deg. angular tool depth becomes 0.7426 instead of 0.750.

Machine Tests Strength of Soldered Joints

BY PAUL H. FAHLE

Most silver contacts contain some graphite to prevent them from "freezing" on short circuits. However, graphite is difficult to weld, even when mixed with silver. Therefore, whenever we weld silver graphit contact tips to copper contact fingers, we use the illustrated machine to test the strength of the joint. It consists of chucks *A* and *B*, so arranged that they



This torsion testing machine gives accurately the torque required to rupture small welded or soldered joints, such as electric contacts

can rotate with respect to each other. Chuck *A*, which grips the silver contact and holds it rigid, slides laterally in solid base *C* when actuated by eccentric clamp *D*. Chuck *B* grips the copper contact finger and rotates it with respect to the rigidly held silver contact. The effect of this rotation is to twist the silver contact off the copper contact finger. The torque required to separate the contact from the contact finger is a measure of the strength of the welded joint.

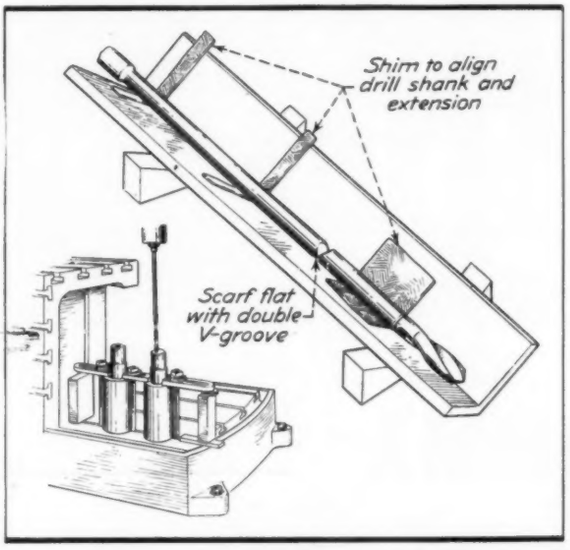
The torque is measured in inch-pounds by moving

fixed weight *E* along the graduated beam *F*. The beam is rigidly affixed to chuck *B* which rotates in yoke *G*. Zero balance of the beam is maintained by counterweight *H*.

Shank Extensions Welded to Drills

BY ARTHUR HAVENS

Recently we found it necessary to weld extensions to standard drills for drilling the center hole in crosshead pins. Although the feasibility of this practice may be doubted by the average welder, it can be done successfully. The most common error that the welder makes is in pointing the extension and the drill to be



When a long-shank drill is needed in locomotive repair work for unusual jobs, we weld the extension in place, using a welding rod with a high percentage of carbon

welded; when arranging round parts for welding they should be scarfed flat with a double V-groove.

If the parts to be welded are of similar diameter they may be laid in a piece of angle iron. If there is a difference in diameters, the smaller one can be shimmed one-half the difference of the diameter to bring it central with the larger part. Needless to say, the correct alignment is very important when preparing to weld a drill. With the parts in alignment, the welder should select a welding rod with a fair percentage of carbon, such as that used for welding locomotive tires. In the event a rod of this type is not available, the best medium carbon rod should be procured.

The flame adjustment for welding high carbon steel is very important. A carburizing flame must be used, with the center of the acetylene extending about 1 in. from the neutral cone. As the carburizing flame is played upon the metal the ends to be welded are both brought simultaneously to a welding heat. No filler metal is added until the glowing surfaces run together at the bottom of the V-groove.

The welder will notice that the puddle is dark and slow-moving, and that there is a strange lack of sparks. This is an indication that all is going well, and that the high-carbon metals are not burning. The weld should be made as rapidly as possible, taking care not to work molten metal with the flame needlessly. If a scum forms over the surface of the weld, it may be dissipated by dipping the end of the welding rod in cast-iron flux.

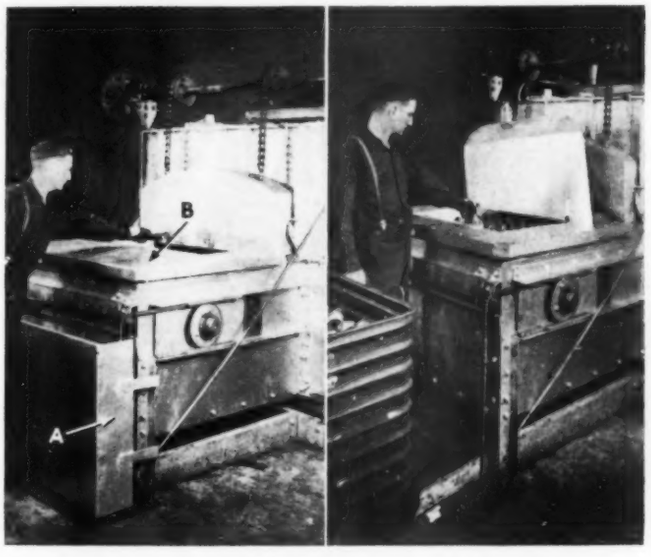
After the weld has been made, it should be ground to bring the shank of the drill and the extension to the same diameter, or if the extension is smaller diameter than the shank, the weld should be ground to the diameter of the largest part. We have used this method of welding extension to drills for special drilling jobs which often occur in locomotive repair work. When at all possible, we do not resort to the practice.

Elimination of Barriers Increases Production

BY O. W. HABEL

The illustration shows how the elimination of a work barrier was accomplished on a heat-treating furnace. This improvement, which permitted the operator to load two furnaces instead of one, resulted in a labor saving of 60 per cent.

The furnace as originally installed is shown at the



This continuous heat-treating furnace as originally installed is shown at the left. The changes shown at the right, providing a normal work area, resulted in a 60 per cent labor saving

left of the illustration. The operator in loading the continuous-belt furnace was required to lean over the guard *A*, which protected the operator from the counterweight used to maintain tension in the continuous belt. In addition, he had to stretch beyond his nor-

mal reach to load the furnace, because that portion of the furnace *B* was required to cover the front roll of the continuous belt.

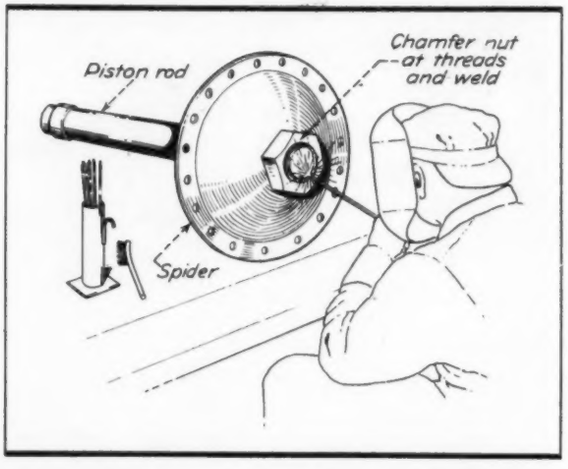
By placing the belt take-up counterweight under the floor, as shown at the right of the illustration, cutting the load opening out toward the operator, and lengthening the belt, we eliminated the work barrier and kept the operator's movements within a normal work space. He now works in a comfortable position, and as stated previously, loads two furnaces instead of one with a resulting labor saving of 60 per cent.

Welded Piston-Rod Nut Stops Engine Failures

BY NOAH DEERING

Several different methods are used to apply the steel spider that holds the cast-iron bull ring on locomotive pistons. Most shop foremen complain that regardless of the care taken when pressing the spider onto the piston rod, they occasionally bend the rod. Quite often a spider becomes loose in service, and an engine failure results.

We assemble the spider as follows, and have had no difficulty with its becoming loosened. The spider is machined so that it will drive onto the $\frac{3}{4}$-in. taper of the rod to within $\frac{3}{16}$ in. of the shoulder. The threads are cut on the rod and the assembly taken to the press. The piston or spider is set on its support under the press and heated with an acetylene torch. The rod is then pressed into place against the shoulder. Water is used to speed the cooling. Before tightening the nut on the rod, it is chamfered as shown in the drawing. After the nut is tightened the assembly is taken to the welder. He fills in the chamfer, using a good grade of heavy coated rod. This fastens the nut to the piston rod and prevents the spider from coming off the rod in service, even though it becomes loose. Since using this method, we have not had an engine failure due to loose spiders.



By welding the piston nut to the rod the spider will not detach itself from the rod in service, even though it may become loose

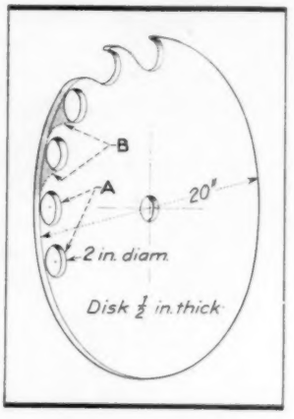
Saving Time With the Bandsaw

BY FRED H. COLVIN

One of the small shops that tackles any job that comes along, took a contract making several special shaped disks as shown in the drawing. They were about 20 in. in diameter, with hooked teeth around the edge, for a special machine being built in a neighboring shop. The disk was about $\frac{1}{2}$ in. thick.

The first step was to lay off as many centers as there were teeth around the periphery of the disk. Holes were then drilled at each center and a trepanning tool was used to cut out the large holes *A* as shown, which were about 2 in. in diameter.

This left the portions shown by cross-hatching *B* to be removed. After the profiles were laid out from a template, a bandsaw was used to cut out sections *B*. With these removed, it only remained to dress up the curved surfaces to fit the finished template. These bandsaws make jobs like this easy.



This disk with hooked teeth around the periphery was made by drilling and trepanning small holes properly spaced around the circumference, and finally removing the remaining metal with a bandsaw

Punch and Die for Knobbing Floor Plates

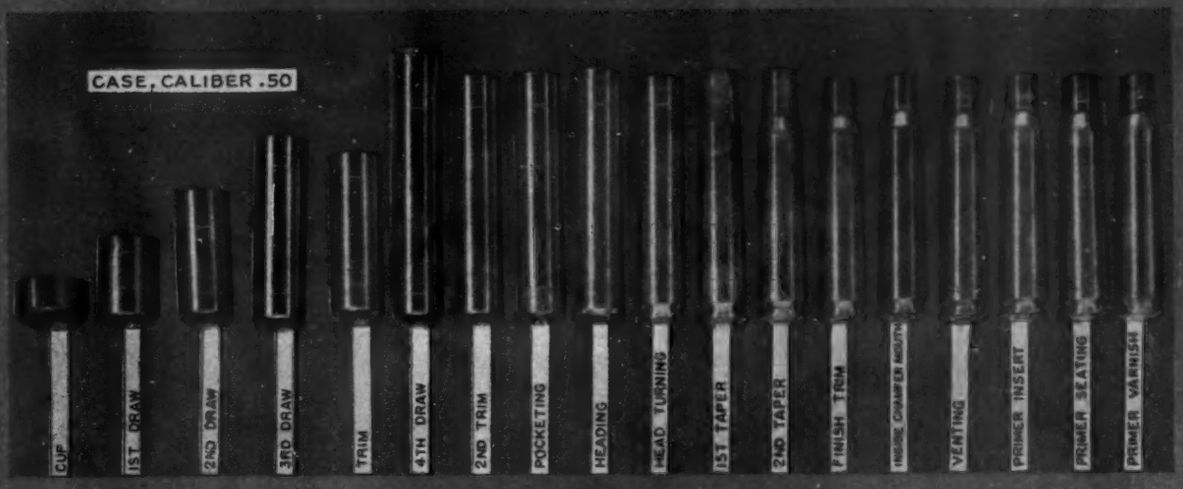
BY A. H. CARROLL

Safety floors are required around enginehouses and back shops, especially where oil is handled. In addition, locomotive steps, runways and aprons are made with safety tread to prevent train crews and machinists from slipping when walking about the engine. Plate manufacturers furnish safety tread sheet, but it is not always available; in fact, at the present time it is extremely difficult to procure. The boiler foreman in our shop therefore designed a punch and die which knobs the plate successfully.

A scrap punch and die designed originally for $\frac{1}{2}$-in. holes were used for the purpose. The original punch was ground $4\frac{1}{2}$ in. short of its original length, and the remainder pointed similar to a center punch. When the punch and die were placed in their respective positions in the press, it was found that $\frac{1}{4}$-in. plate would be punched with knobs or impressions which when spaced properly made a satisfactory safety-tread plate. However, when tried on $\frac{3}{16}$-in. plate it was discovered that shims had to be placed under the die to raise it so that the impressions made by the punch would be sufficiently deep. The same held true for $\frac{1}{8}$-in. plate.

Armament

SECTION OF AMERICAN MACHINIST



AMMUNITION FOR THE AIR FORCE

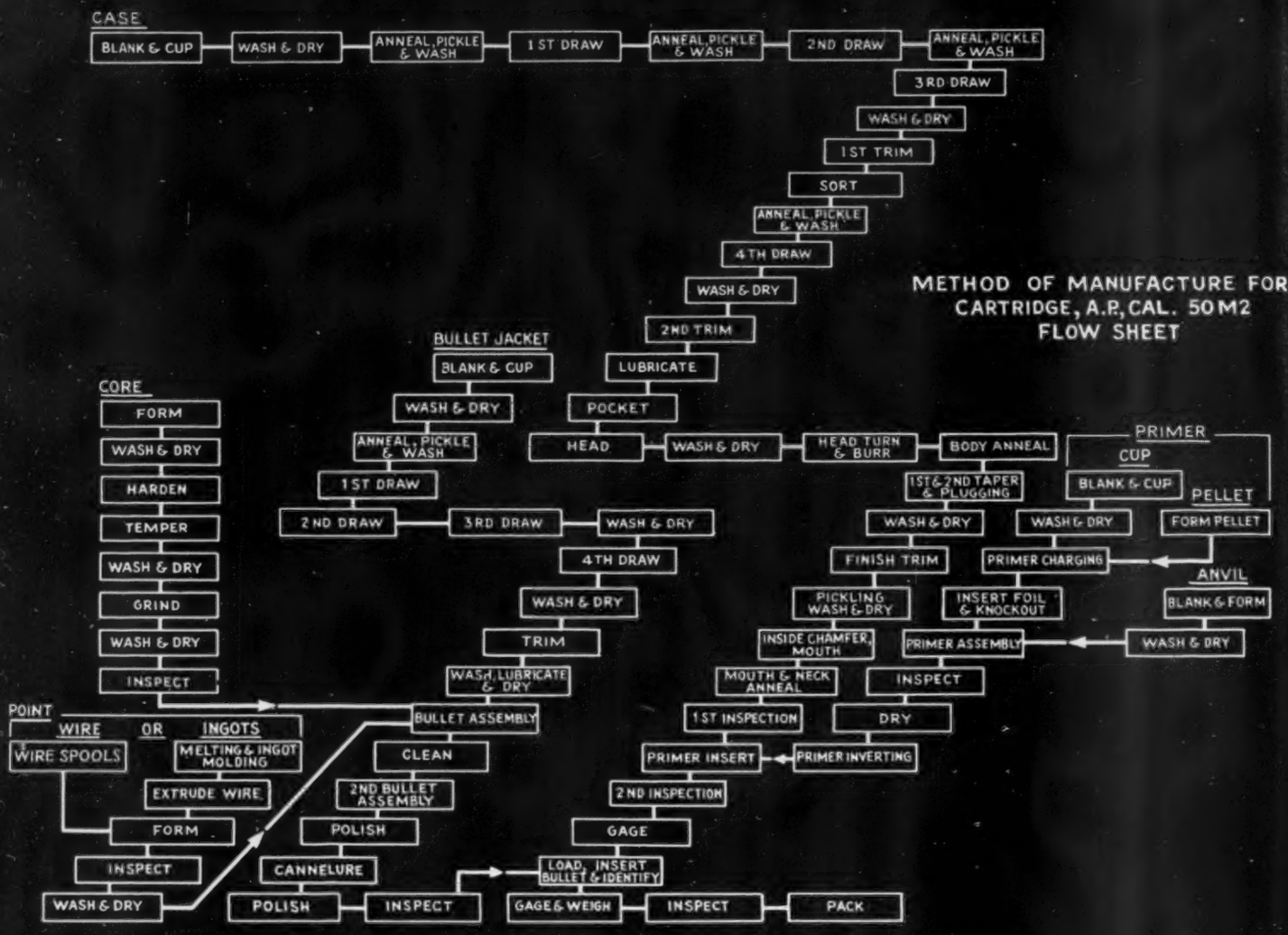
Cartridges that will not jam or hang fire may decide the result of a dog fight above the clouds. Such dependability rests on precise workmanship in the shop

EXPERIENCE GAINED from the war in Europe has shown the need for emphasis on the production of vast quantities of machine gun ammunition. Although guns up to 37 mm. are now carried by heavy pursuit planes, the principal weapon, both for pursuit planes and bombers, is the machine gun particularly the cal. 0.50 Browning. Cal. 0.50 field and anti-aircraft machine guns use the same cartridge. Pending the completion of new plants, the principal source of this ammunition is the Frankford Arsenal.

The cal. 0.50 cartridge is made in three types: ball, tracer and armor piercing. The tracer and armor piercing bullets are distinguished by red and black paint on the nose respectively; ball cartridges are unmarked.

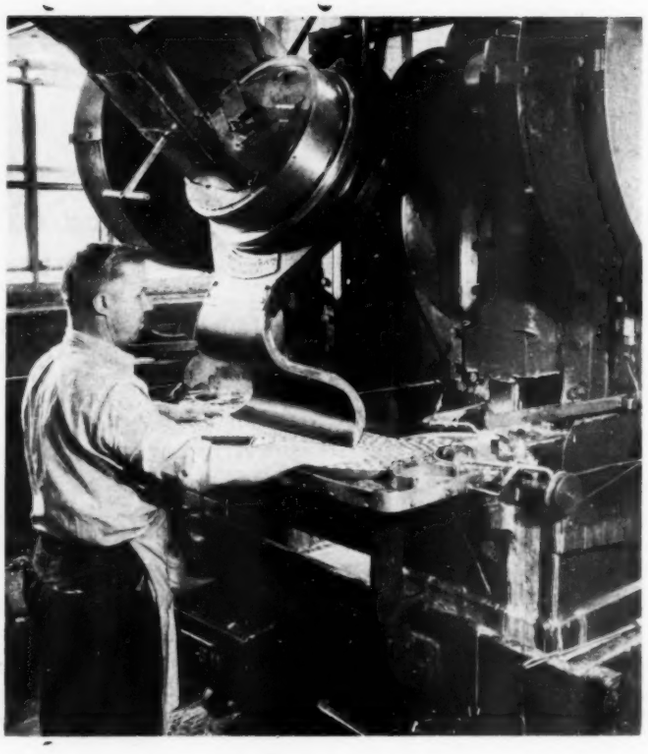
It can be readily understood that great accuracy is essential in making ammunition for machine guns carried by aircraft. Many of these guns are operated by remote control hence any jamming will put the weapon out of commission. Some guns are mounted so they fire between the blades of a whirling propeller by means of a synchronizing device. If the ammunition is not accurately made and assembled, a hang-fire may be caused that will destroy the synchronization and may cause damage to the propeller.

The demand for precision that runs into limits of



tenths of thousandths is accompanied by mass production that overshadows all previous ideas of mass production in the astronomical quantities involved. At present Frankford Arsenal is turning out millions of rounds of small arms ammunition a month which is many times the output of three years ago and in comparison makes the maximum output during the World War appear insignificant. Through the adoption of new production methods and the systematic training of personnel this huge expansion has been accomplished with improvement in quality and decrease in cost.

Much of the machinery for cartridge making now used at Frankford was devised and developed by Arsenal personnel in cooperation with machine manufacturers. Private makers of small arms ammunition must devote most of their facilities in peace time to the production of cartridges and shell for sports purposes which involves a large variety of types and sizes. The Arsenal has the advantage of uniformity and quantity; hence its methods are in advance of those used by outside manufacturers. As a consequence the Arsenal's equipment set-up is now serving as a model for three plants now under construction



that will soon be operated by private management.

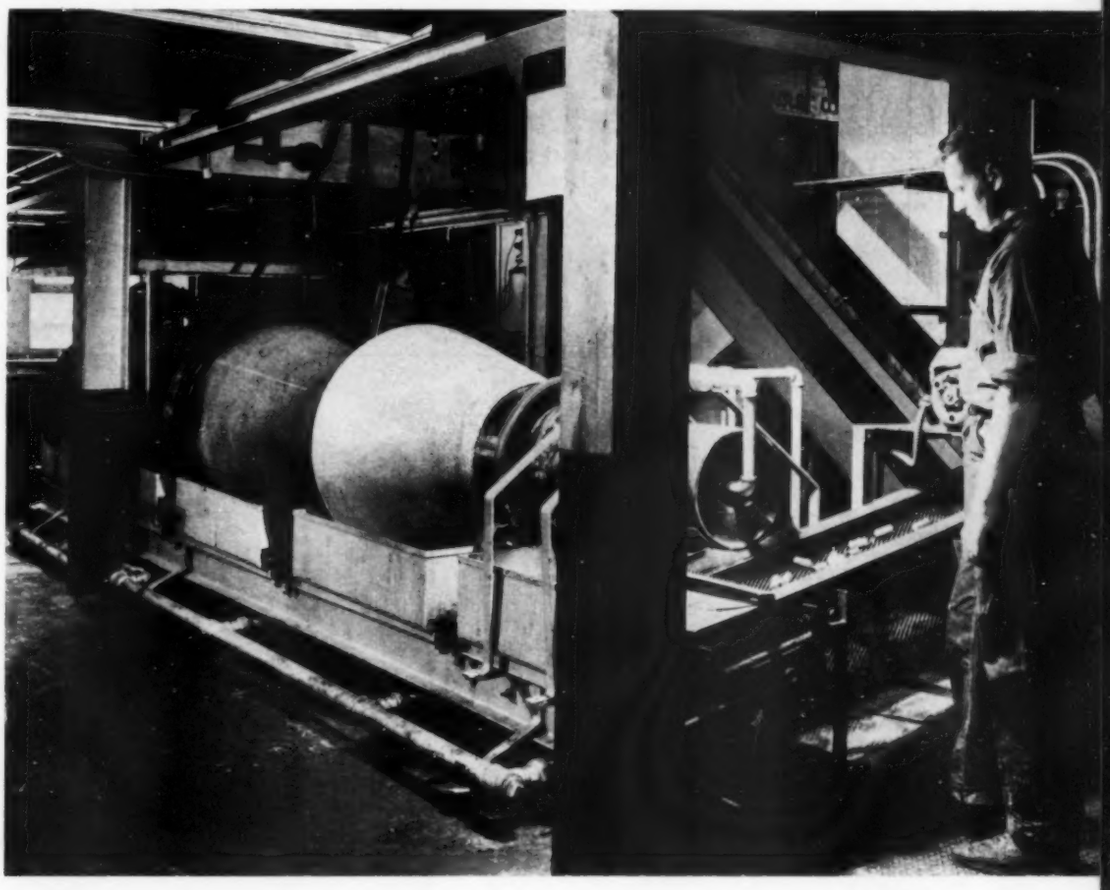
The following description will be confined to the cal. 0.50 cartridge because of its importance in current military planning. A round consists of four main components: the cartridge case, the bullet, the propelling charge, and the primer. The accompanying flow sheet gives an idea of the large number of operations needed to complete a single cartridge. Altogether there are 176 separate steps in the manufacture of a cal. 0.50 cartridge. On an average 26 days elapse between receipt of the raw material and final packaging of the ammunition.

Completed in One Plant

Unlike artillery ammunition, machine gun cartridges and other small arms sizes are made complete, tested and packed for shipment, in one plant. In the artillery sizes shells are made at one plant, cases at another, fuzes at another, and loading and assembly are done at still another. Naturally the quantities of explosives used in the larger ammunition makes it advisable to segregate loading operations. For the small arms sizes danger of accident is minimized by carefully controlling the amount of powder in any one spot. The supply of explosive in the plant, in each department and at any one machine, is restricted at all times.

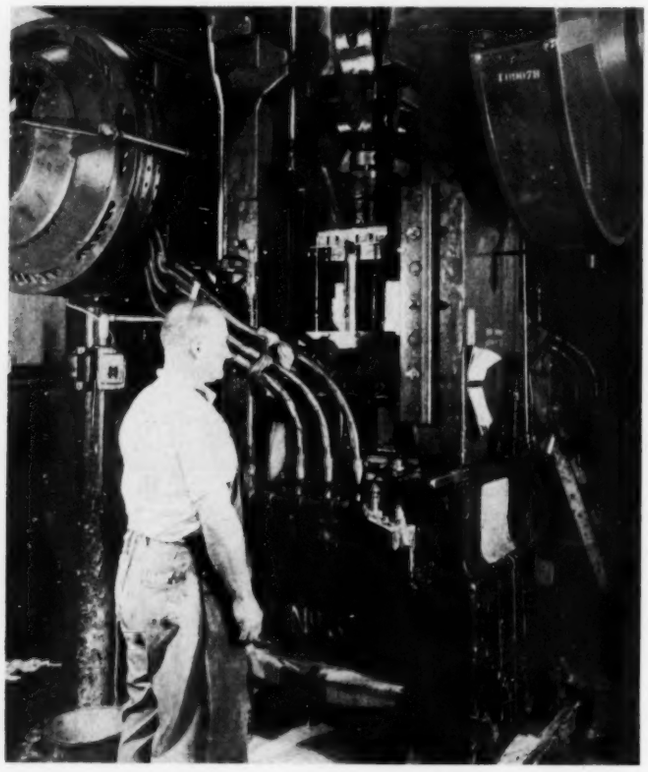
Cartridge brass (70 percent copper, 30 percent zinc) is used in making cartridge cases. It is purchased by Frankford Arsenal in the form of cups in order to minimize the handling of scrap. Formerly the Arsenal acquired considerable brass in the form of sheets and stamped out its own cups, but this meant that a large amount of the material had to be returned to the brass mill for salvage.

In the description of steps in the manufacture of the cartridge case and the bullet, it should be noted that a great deal of attention has been given the solution of the problem of material handling. The importance of getting a smooth work flow in handling such vast quantities of small parts is obvious. In many instances, the existing building arrangement has restricted the choice of material handling equipment. Only in a few cases are conveyors used. The general method of handling is to have the machine performing a given operation eject the part directly into a small drop-bottom steel truck. Machines are fed from overhead hoppers which are supplied from a balcony to which the steel trucks are hoisted by means of an electric crane after the completion of



The first draw on the cartridge case is done on a double-ram Ferracute press. Cups are fed through chutes from the mezzanine floor above

From the annealing furnace in the rear, cases are carried forward through pickling and rinsing tanks until they reach a lateral conveyor screen for drying. Another conveyor returns them to the mezzanine



Second, third and fourth draws are performed successively on Bliss single-ram presses, each equipped with three sets of tools. Note the device which supplies cases, open side up, through flexible tubes

each operation. Trucks used for cartridge cases are 4.8 cu.ft. in size and hold about 5000 pieces.

For the first drawing operation on the cartridge case, the cups are fed down to the surface of a flat table which serves the double purpose of giving an opportunity for inspection and a means for feeding them into the machine. The operator examines them carefully while pushing them on two flat disks which carry them into the working position of the machine. For this operation a double-ram press is used, one ram opposing the other. The punch is forced into the cup to give it its first draw; the finished piece is stripped from the punch on the return stroke and drops into one of the trucks. A soap compound is used for all drawing operations; a small percentage of lard oil is added to suit conditions of the brass.

After each draw the cartridge case must be annealed, pickled and washed. Cartridge brass is work hardened by being drawn in a press and must be softened by heating and slow cooling before it can be worked again.

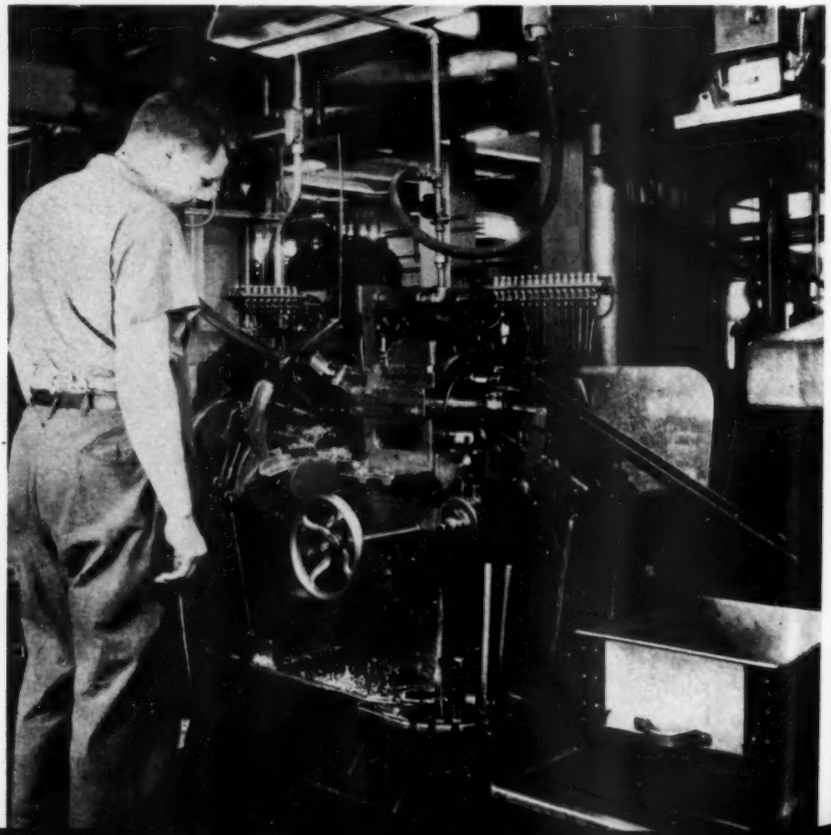
The work pieces are elevated to the mezzanine and fed into Lindberg continuous electrical annealing furnaces. Each case is in the heated zone for a definite time during its travel through the furnace

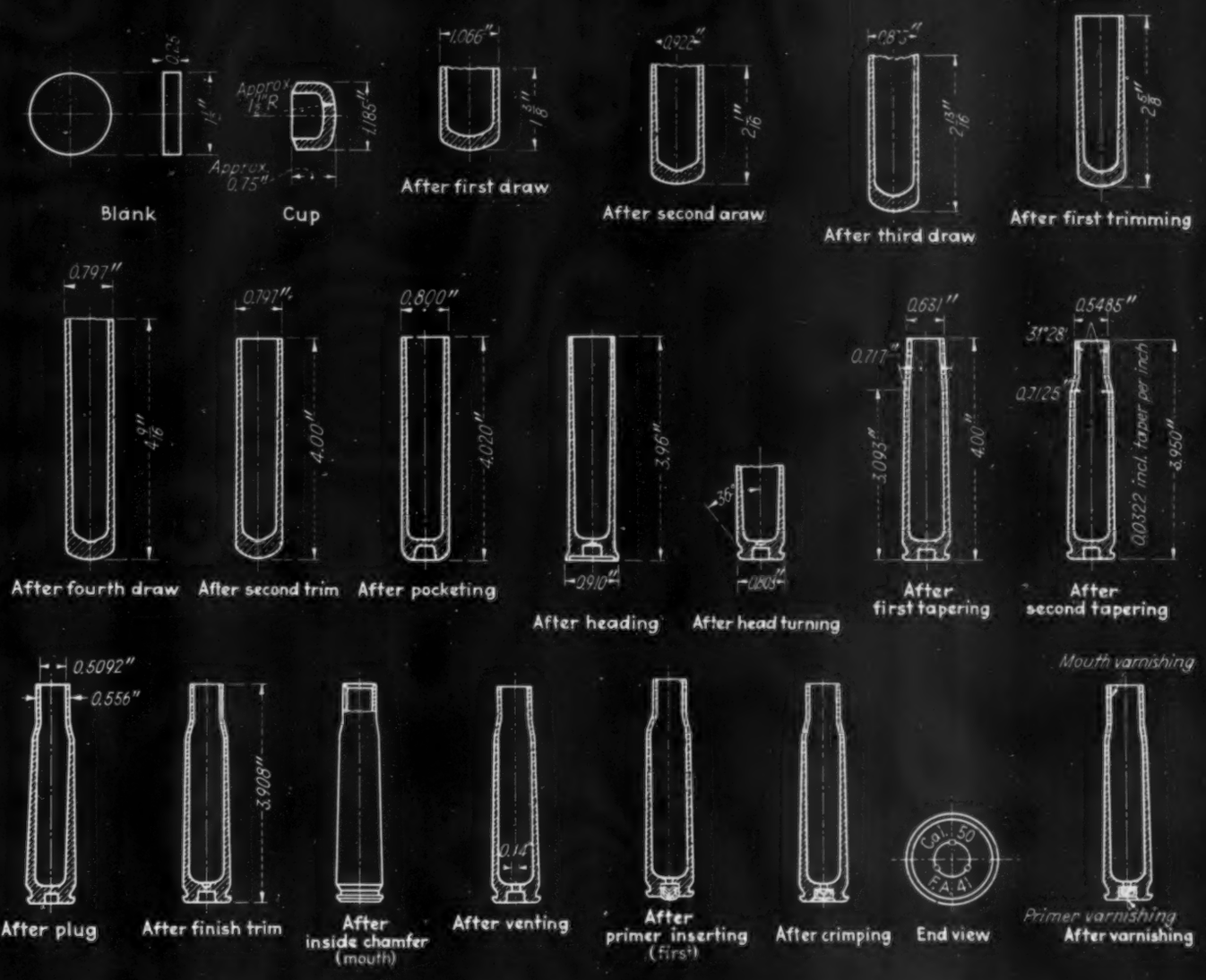
→

Steps in making a cal. 0.50 cartridge case are shown on the page opposite

After most operations, parts ejected into shop trucks, are lifted by an electric hoist to the mezzanine for feeding into the next machine. The operation shown is heading the case on a horizontal upsetter

The upset head is machined on a Davenport five-spindle automatic. The auxiliary tote pan over the shop truck reduces the height through which the cases drop, giving less likelihood of damage





and is elevated to the proper annealing temperature. At the discharge end of the furnaces the cases drop to a cooling conveyor which elevates them and transfers them into a continuous pickling machine to remove the surface oxide which forms in the furnace. The speed and length of this conveyor is such that the annealing heat is largely dissipated before the work is deposited in the pickling bath. The parts are carried successively through the pickling bath which consists of a two percent solution of sulphuric acid, then two rinsing baths, a neutralizing bath of soap solution and a hot water rinse which expedites drying. Two other conveyors carry the parts out of the bath to the mezzanine ready for the next operation.

The second, third and fourth draws are done in Bliss presses each equipped with three sets of dies. The cases are fed to these presses from the mezzanine by dumping the shop trucks into hoppers which supply each machine, then through metal tubes to the machine proper. These presses are equipped with "pinwheel" feed dials which have a series of pins set angularly around their inside circumference. The pins enter the open ends of the cases, pick them up and deposit them, closed end down, into the flexible tubes. After each draw they are stripped from the dies and dropped to the bottom of the press into trucks. The cases again go through the continuous annealing, pickling and rinsing machinery just described after the second and third draws.

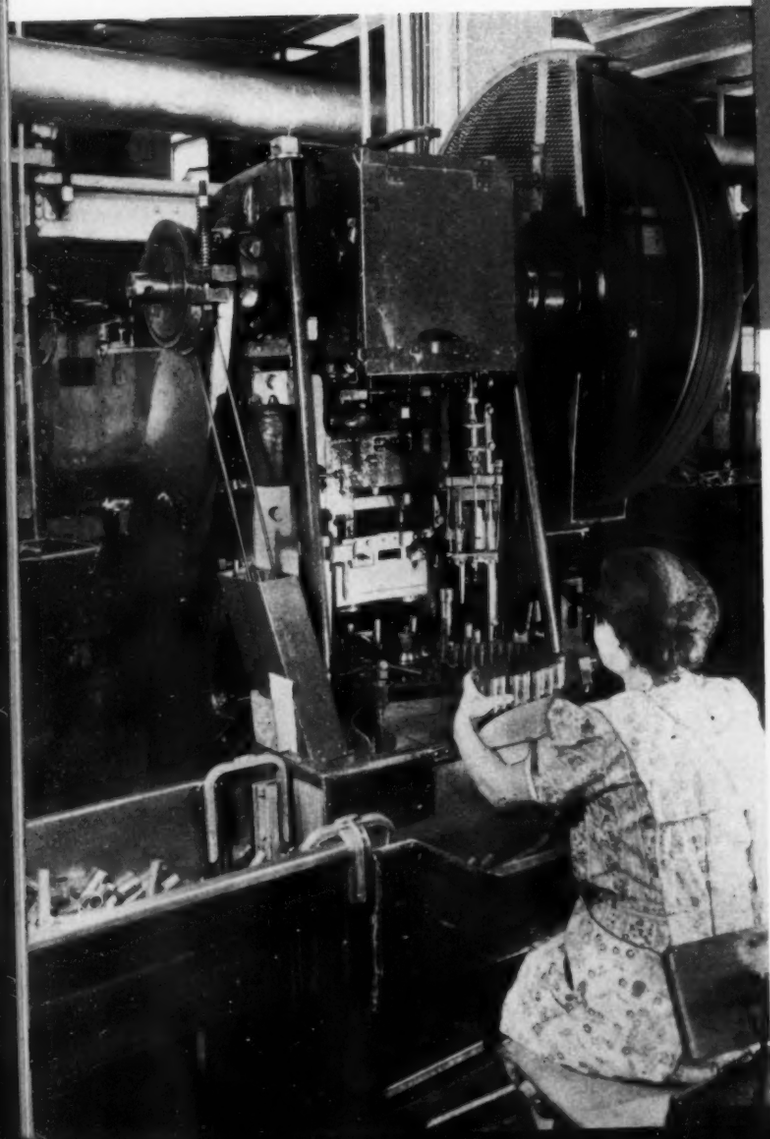
As they are drawn longer and longer, the brass walls grow thinner especially at the open ends where feather edges are formed. For this reason it is advisable to trim the cases to length during the process of forming. Trimming is done after the third and fourth draws in special machines.

After the fourth and last draw, the cases are ready for heading. Two Ferracute presses are used, each having a different set of dies. The first does the pocketing or forming the recess for the primer hole, while the second does the heading which includes upsetting the end and marking the case for identification. The heads are next turned in a Davenport five-spindle automatic screw machine. This operation consists in cutting the extractor grooves, facing

Cases are carried through a gas-fired tunnel for the body anneal; they are fed to the machine through a vertical tube and knocked off by a rotating paddle

Both body and neck are tapered in one machine which also performs the functions of greasing, inspecting and plugging; hand feeding is used so the operator can coat the cases with oil and visually inspect them

A holding device which resembles the powder chamber of a gun, chucks each case while it is trimmed to length; ejection is aided by an air blast



the end of the case and chamfering the primer pocket. By dividing up the cuts on a five-spindle machine it is possible to do this work at a very high rate of speed.

Next the cases are body annealed. They are fed through a hopper to a rotating table on which they stand vertically with the head end just covered by water. The cases pass through a tunnel, fired by gas jets which heat the cases up to annealing temperature. An open space gives the cases time for cooling after which they are knocked off into a truck by means of a revolving paddle. The annealing cycle is checked every half-hour by a grain size analysis of the cartridge brass.

The next operation is tapering. This step consists in tapering the body, forming a shoulder and then tapering the neck section which holds the bullet. This Waterbury-Farrel machine is typical of many multi-operation automatics employed at the Arsenal in that it is well provided with safety devices designed to prevent defective work from getting by and also to prevent damage to the machine. This particular machine is not fed through chutes, but by hand. The operator has an opportunity to give the cases a visual inspection at this point and to coat them with a thin film of oil. After annealing the cases are soft; using a chute feed at this point might cause their edges to be damaged.

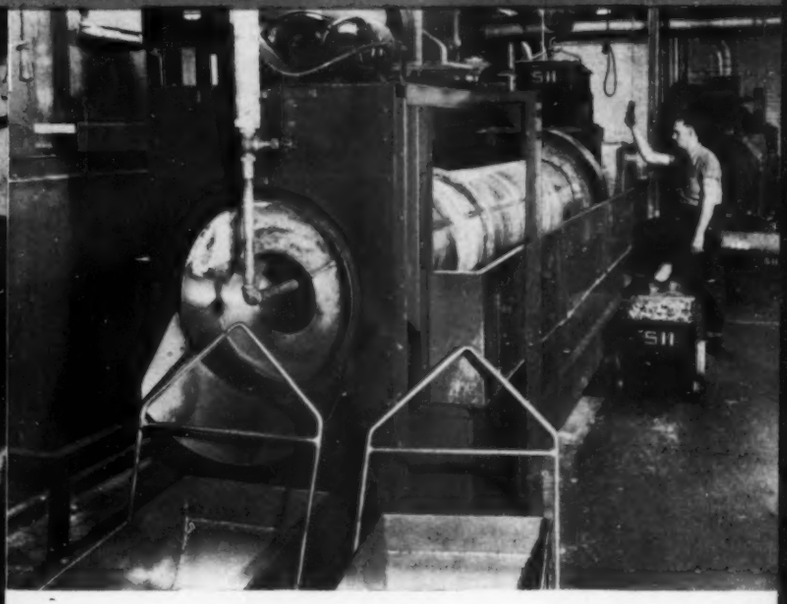
The first step in this machine is to lubricate the inside of the mouth of the case. The second station is called a foreign matter detector. It consists simply of a finger which reaches into the case and if there is any material inside, causes it to stop the machine automatically. At the third station a tapered plug, which is called the mouth setter, comes down with each stroke of the press to make sure that the mouth is perfectly round before tapering. Then there are two tapering operations, the first for the body and the second for the mouth and shoulder. These are simple forming die operations. After they have been completed a plug comes down with the motion of the press to check the size of the mouth opening.

After tapering the cases are trimmed to length. They are held in a chuck which simulates the cartridge chamber and are revolved while being trimmed by means of a cutting tool. This tool looks somewhat like a circular milling tool, but only one tooth is used at a time. The other cutting edges are provided so the tool can be rotated as one tooth becomes dull, thus greatly reducing the number of tool changes required. A blast of air blows out the case and assists in ejecting it from the chuck. Here again the work is fed by hand to provide an additional opportunity for inspection.

As a final precaution before loading the cases are again pickled. This is to remove all oil film especially

Mouth annealing is accomplished by passing the cases through a screw-fed furnace fired by gas. Here again the continuous workflow principle is utilized

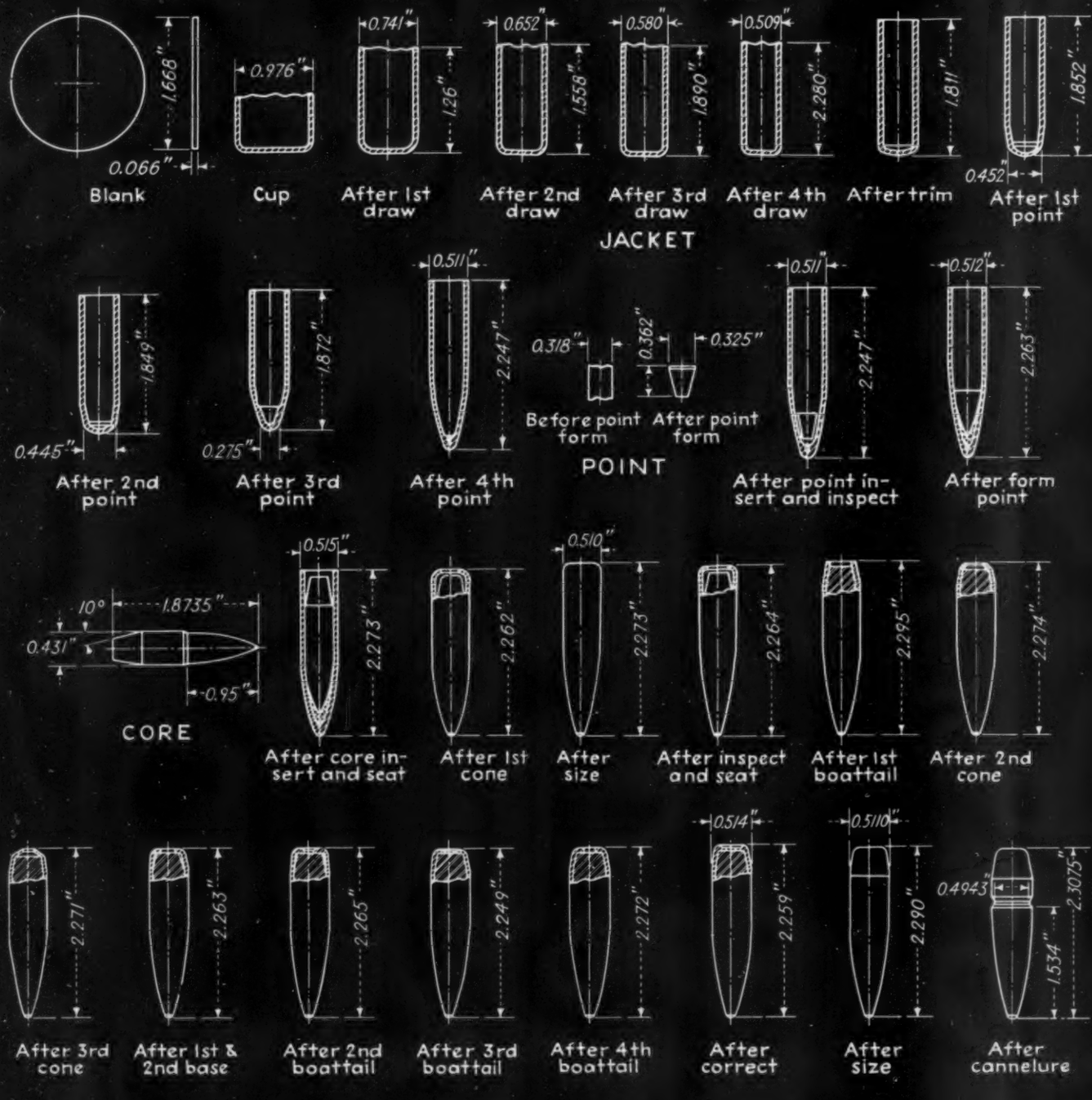
After the final trim and before mouth anneal, cases are pickled and rinsed in this Blakeslee machine. The pipe at the near end supplies a hot water spray

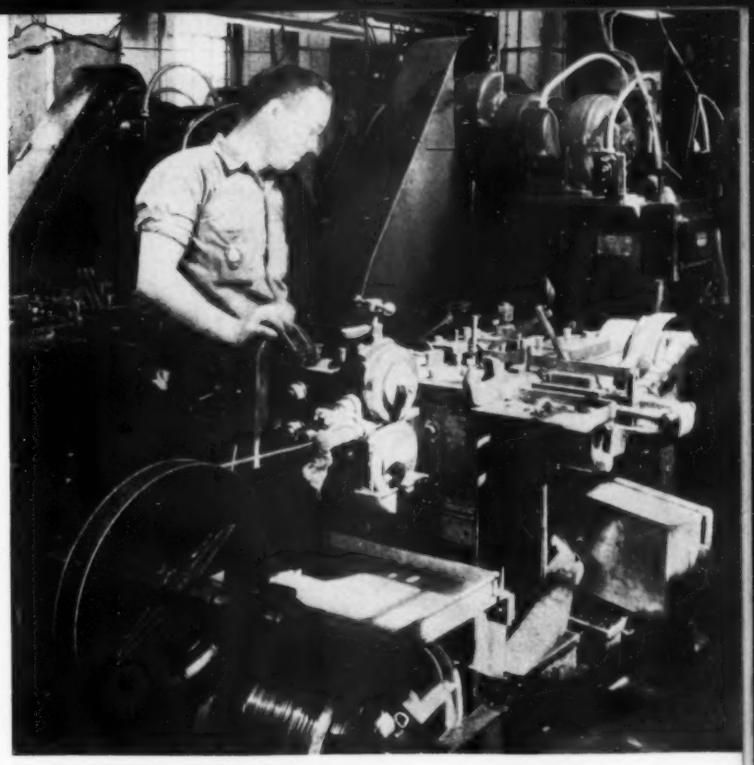


that in the primer pocket which is difficult to get at any other way. The work is placed in a stainless steel drum provided with an internal helical guideway which carries it along the length. A stream of cold two percent sulphuric acid solution is supplied at the starting end and is carried along the drum with the cases until it reaches a perforated section where it runs out into a tank below. At the discharge end a water spray flushes away the pickling solution and is caught in a tank below the drum. The cases are then transferred to a tumbling barrel for cleaning and polishing. They are put in a solution of Penn salt with hot water and then liquid soap is added. Revolving in the barrel with this solution gives them a bright clean finish.

The cases are then burred in a simple vertical spindle machine in order to smooth off the trimmed edge. These machines are operated by a cam mechanism which feeds a burring reamer as each case is brought into line under it.

In order to soften the mouth before the bullet is inserted, another annealing operation is performed. The cases are held at an angle of about 30 deg. and fed in a straight line by means of a screw. Meanwhile a series of gas flames are played on the mouths in order to produce the proper strain release.





Lead points used on all types of cartridges are made by extruding the ingot into wire and then forming in the upsetting machine as illustrated

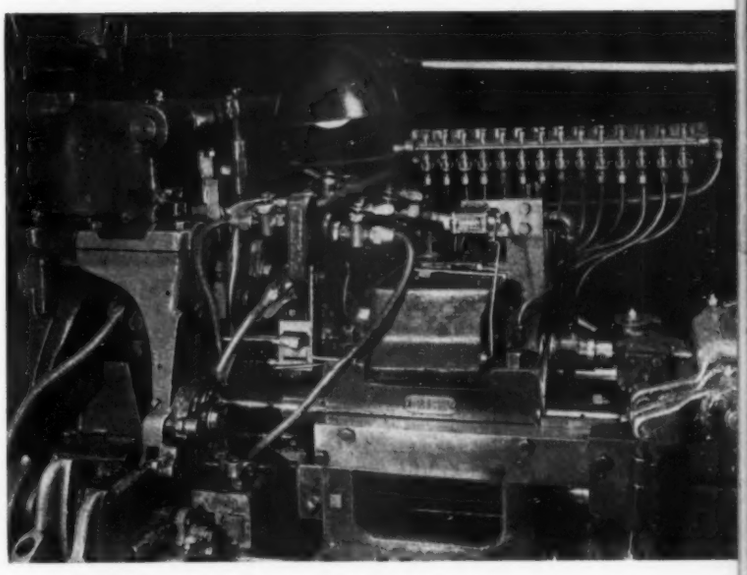
While the cases are the same for all cal. 0.50 cartridges, the bullets differ according to the type. All of them use a gilding metal jacket formed to a point. For the ball cartridge the gilding metal jacket is filled with a lead slug and a cold-rolled steel core. The tracer bullet contains a lead slug and tracer mixture. The bullet for the armor piercing cartridge has a small lead point and a hardened tungsten-chromium steel core. The lead point in all cases gives the bullet its proper balance.

In every case the lead consists of 90 percent pure lead and ten percent antimony. The lead slugs are first extruded into wire by means of hydraulic presses and then upset to form the point in a Waterbury-Farrel horizontal single, short stroke heading machine. The slugs are held to tolerance of $1\frac{1}{2}$ grains in weight. Both the cold-rolled steel and alloy steel cores are made by conventional operations in Davenport five-spindle automatic screw machines.

The armor piercing cores are heat-treated in continuous American gas furnaces, controlled by Brown recording pyrometers. The furnaces are gas fired and carry the cores along their length by means of a helical path. The work is discharged into quenching tanks.

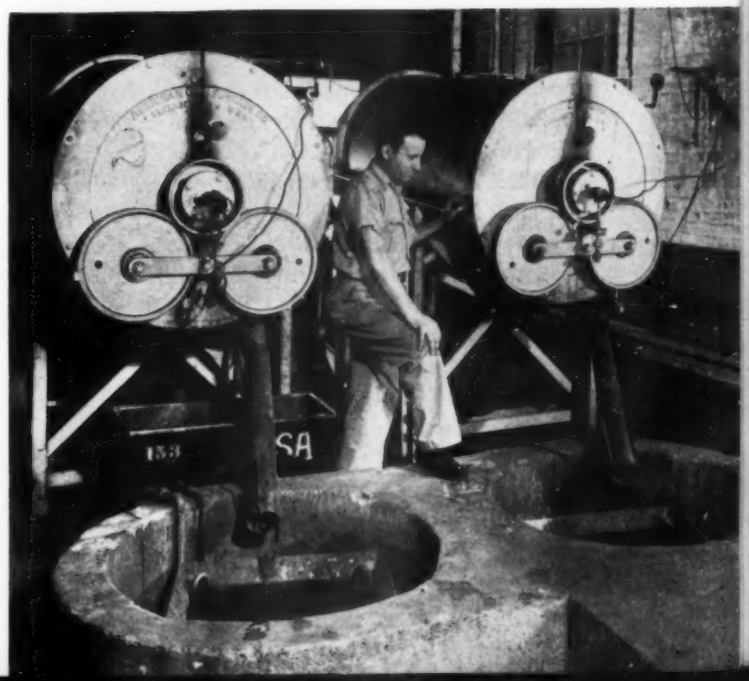
The cores are drawn in Lindberg circulating air furnaces. They are then washed in a continuous machine and go to Cincinnati centerless grinders, equipped with hopper feed, for grinding the outside diameter to accurate size. A "go" and "not go" ring gage is used to check the cores as they come off the grinder.

Straight line assembly machines made by Waterbury Farrel are used to assemble the gilding metal jacket with the lead slugs and steel cores. The jackets have been previously drawn in four steps and

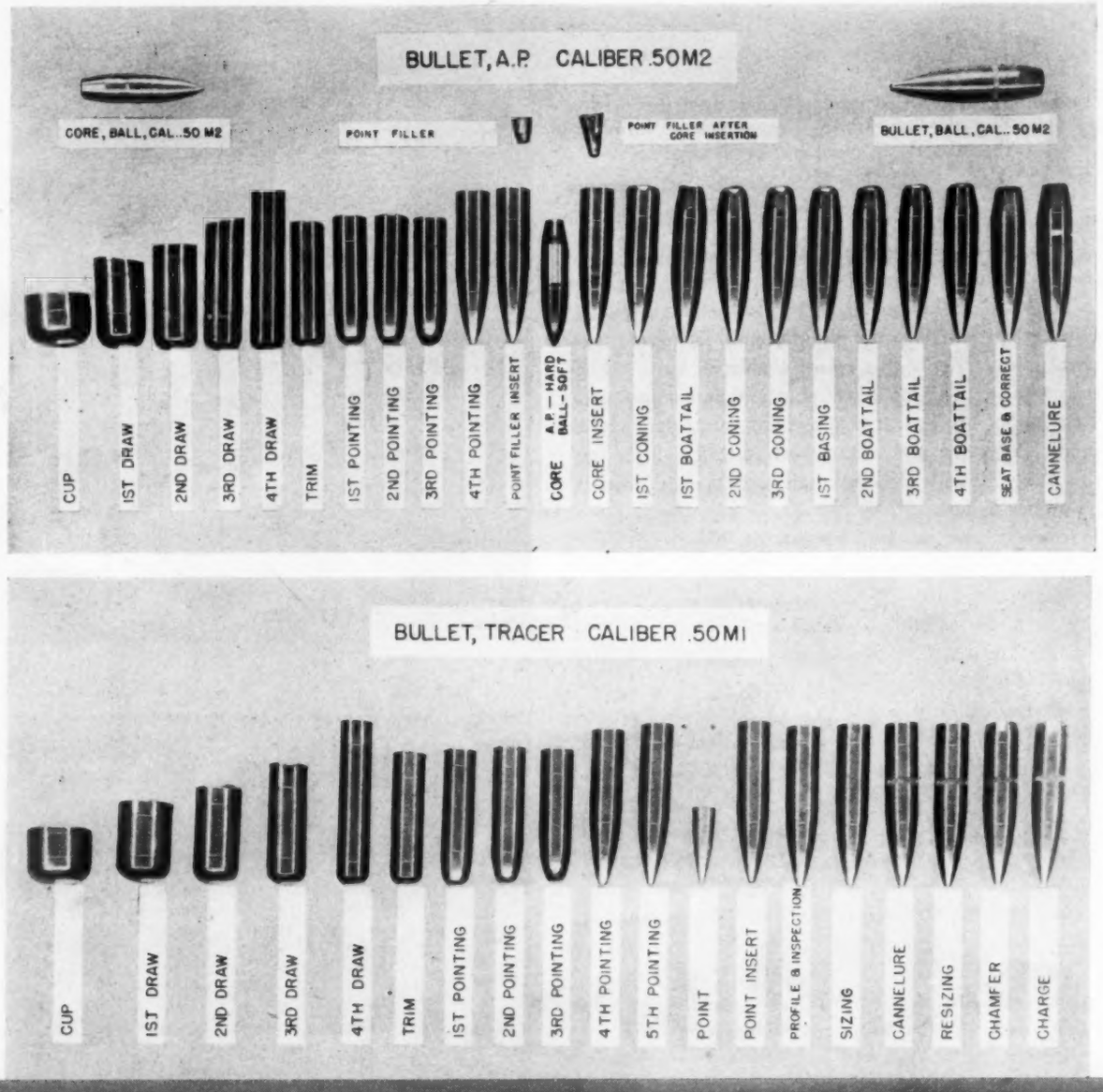


Jacket, point and core which go into an armor-piercing bullet are processed as shown on the page opposite

Cores for armor-piercing bullets are machined on a Davenport five-spindle automatic. One of them partially finished may be seen at the lower left



Armor piercing bullet cores are hardened in a pair of American continuous gas-fired furnaces. The heated parts drop through chutes into water tanks



Operations on the ball and armor-piercing bullets are shown above. The tracer bullet below has a tracer charge added automatically

trimmed. Cups made of gilding metal (90 percent copper, 10 percent zinc) are the raw material. They have already been annealed and do not have to be annealed again during the four draws that bring them to the final shape.

Bullet assembly is accomplished on two automatic machines; the first has eleven stations and the second seven. In addition to inserted lead slug and the core, these machines are provided with safety devices which check the thickness of the jacket and detect any foreign matter before crimping the jacket to complete the assembly.

On the ball cartridges and the tracer cartridges, the bullets are boattailed in this machine and then carried to a feed dial which puts the cannelure groove in them. The armor piercing bullet cannot be handled in this way because of the hard core, so a crimping groove is cut in the outside of the jacket in a separate operation after assembly to provide a means of fastening the bullet to the cartridge case. The base of the tracer bullet is chamfered to facilitate entry into the mouth of the case and prevent deformation of neck of case.

Cartridge assembly begins by inserting the primer into the recess provided for it in the head of the case. This is done in a straight line machine which performs a number of additional operations. These consist first, in punching the primer vent in the web of the primer pocket. The case is passed from station to station automatically. Next the primer is inserted,

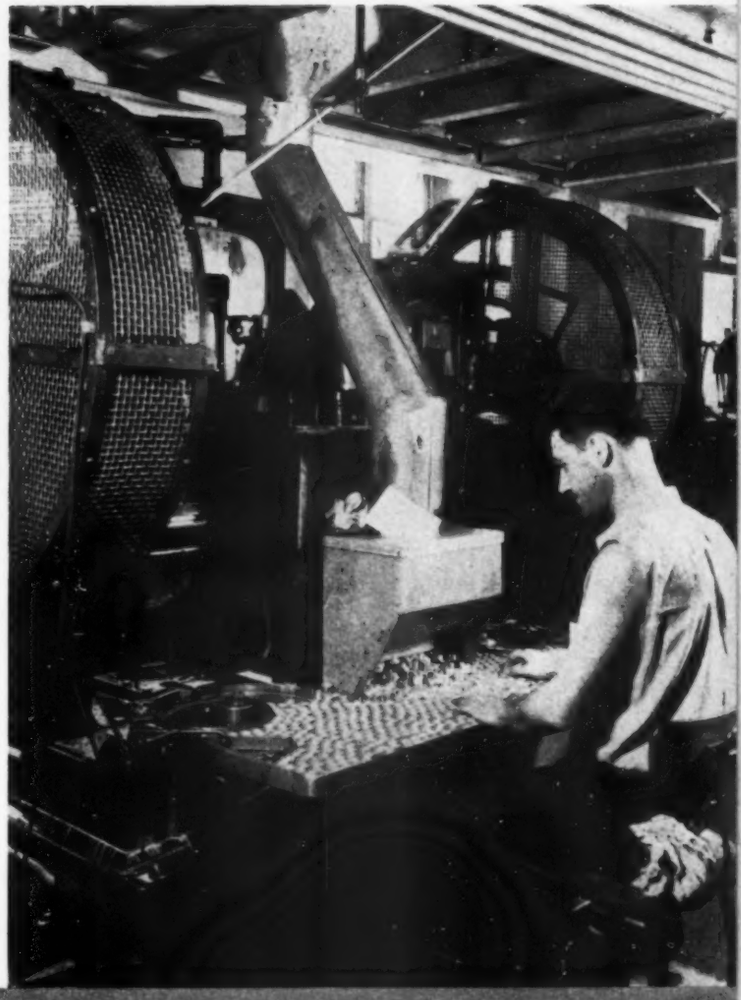
crimped into the case by a three-point stab, and the case is carried along so that it passes underneath the file which removes any burr. Then a small brush applies a drop of shellac to the primer, forming a watertight seal. At the same time a sealing compound is sprayed from below to the inside of the mouth of the case so that the bullet assembly will also be watertight.

This machine is provided with a number of safety features which include a foreign matter detector and an automatic inspection for absence of vent hole or primer which will trip the case and remove it from the machine. The primers are carried along on a steel tape until they reach the assembling position. If, however, a primer becomes inverted, it is detected by a finger which automatically ejects the case from the machine.

It is readily understandable that in resorting to these automatic continuous machines for multiple operations great precaution must be provided so that every step will be performed accurately. Cartridges in the past were made by means of a series of single operations which enabled the operator to examine each step as it was completed. Since the present rate of production does not permit this, mechanical means are provided in these newer machines to detect any malfunctioning in the machine itself or any off-standard work.

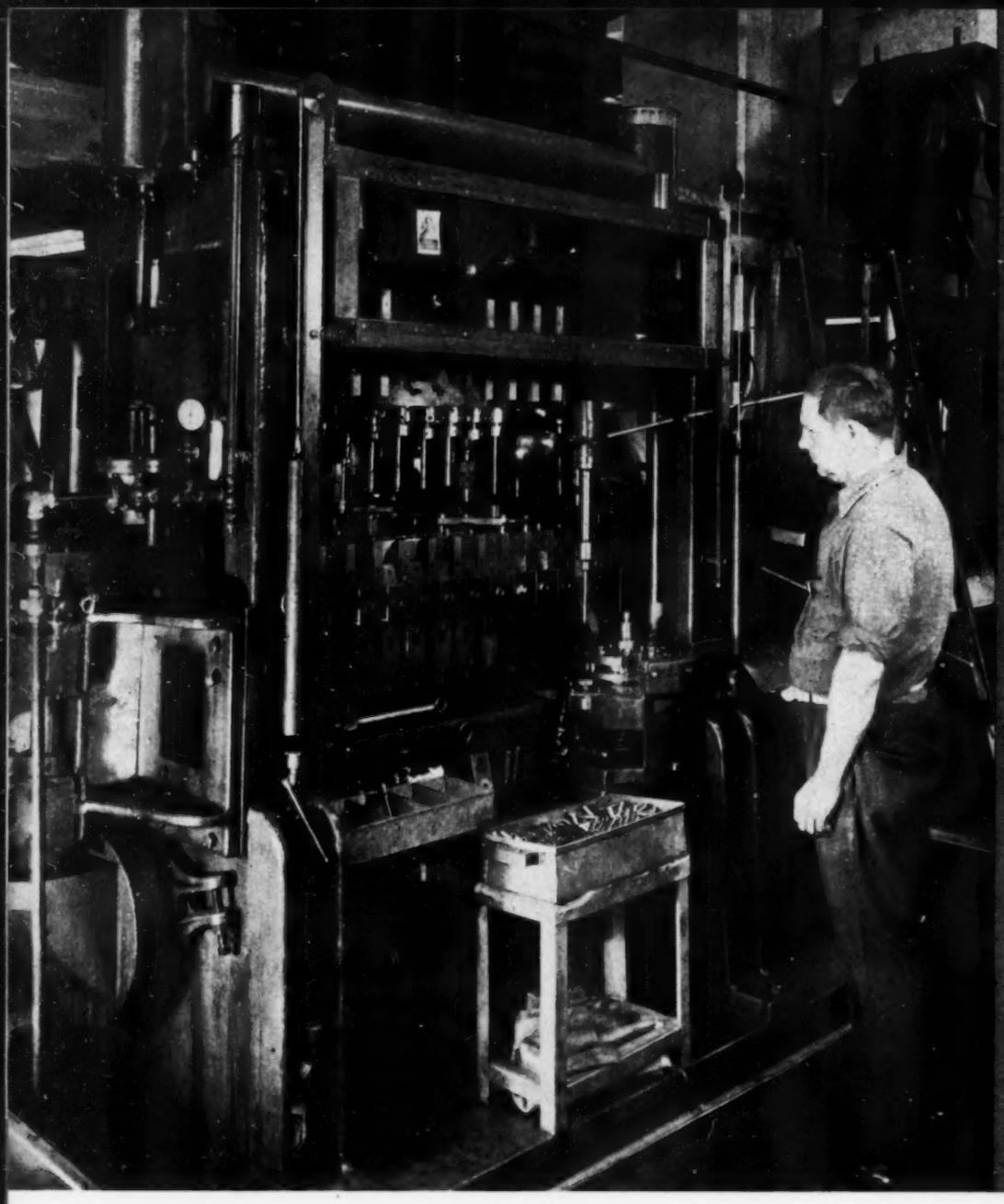
Cases and primers are given a 100 percent visual inspection which is expedited by a machine that carries them along by means of a lead screw. The cases are tilted at an angle of approximately 45 deg. and mirrors are provided at the top and bottom so the ends may be viewed by the inspector simultaneously. Any defective cases are removed from the machine and some of them can be quickly corrected by means of a tapered plug if the mouth is a little out of round or dented. The cases also pass through a gage which rejects any that are overlength.

Loading comes next. This is also accomplished in a straight line automatic machine through which the cases are fed while the various operations are synchronized with its progress. The first station has a mouth spreader which makes sure that the mouth is round and of the correct size. Then the powder is



Bullet jackets of gilding metal are formed from cups in a series of operations similar to those on the cases. Lighter presses are used, and annealing between draws is unnecessary

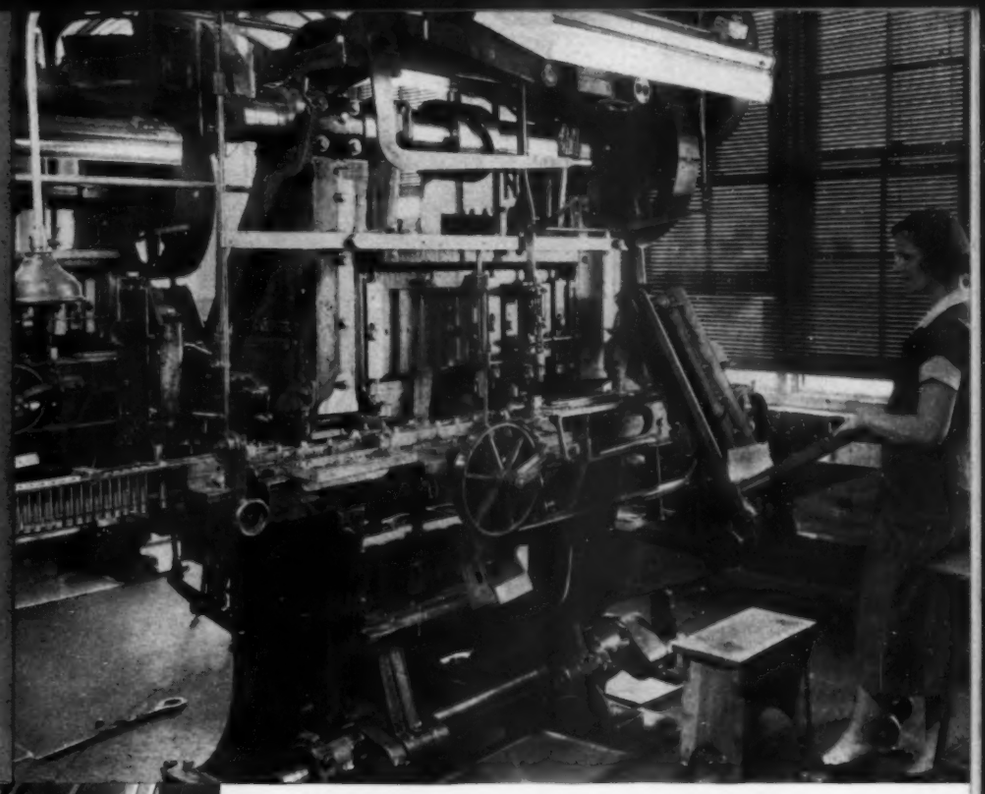
After hardening, cores are ground in a Cincinnati centerless grinder. An overhead feeding device eliminates gaps between parts to give increased production



Bullet assembly is performed in a progressive press. Tracer bullets which have a soft core are fed to the rotating disk at the right where the cannelure groove is rolled in

loaded into the case by means of a funnel and a slide whose opening is of a volume to hold a predetermined weight for each charge. The following station has a finger which comes down with each stroke to check the height of the powder in the case, thereby automatically determining whether or not the proper amount of propellant powder has been deposited in the case. Any lack of uniformity in the amount of the charge is at once detected and the shell is removed from the machine. At the next station, the bullet is inserted, and at the next it is pushed down into correct position. Then follows the crimping station in which the mouth of the case is crimped by rollers into cannelure in the bullet. The assembled cartridges as they leave the straight line conveyor on the machine go first into a dial on a horizontal axis from which they are transferred semi-circularly to a second dial on a vertical axis. In the process of these transfers, the cartridges are inverted and hang from the second point downward. In this position the points are painted as the dial rotates. The cartridges are held by their ejector grooves in a series of radial slots. As each cartridge is inserted in the dial it goes into a new slot in the periphery and forces the inner cartridge in this slot out to a chute at the center of the dial. By means of this arrangement the cartridge will travel around the dial a sufficient length of time to allow the identification varnish to dry.

Gaging, as well as manufacturing operations, is mechanical and automatic in the final inspection of cartridges. Cases, for example, are fed through a machine with six separate gaging stations. A crank mechanism causes the gages to advance, contact the workpieces at each station and then withdraw. If the gage at any station does not fit the work is automatically rejected. The variations in sense of touch



Primers are assembled to cartridge cases in a straight-line machine. The cases travel from right to left while primers are inserted, crimped in place and waterproofed with shellac

Mirrors above and below the cases facilitate visual inspection of primer and mouth simultaneously. The workpieces are supplied through the tube at the left and are carried past the operator by means of leadscrews

inherent in manual gaging are entirely eliminated.

A similar machine inspects the cartridges after loading. Here each round is checked for over-all length, profile and alignment. After gaging on a circular drum, each cartridge is transferred to an arm of a revolving spider. Each arm is counterbalanced with a weight sufficient to keep it horizontal if the cartridge weight is standard. If the cartridge is light it rides high on the arm and is pushed off by means of a stop before reaching the regular ejection station. Likewise overweight cartridges are sorted out automatically.

Regardless of the many inspections that are made on a cartridge during manufacture the final test is to prove it under actual fire. In this way the ballistic properties as well as the mechanical functioning of the cartridge can be observed and checked.

One of the tests performed at the Arsenal is to check the sensitivity of the primer by means of a drop test. In this inspection, steel balls are dropped at various heights until the primer is fired. If a cartridge primer is detonated below a specified minimum the lot is rejected. This test's importance lies in the fact that cartridges may receive comparatively rough handling in service. Primers must not be too sensitive, but must function by impact of firing pin.

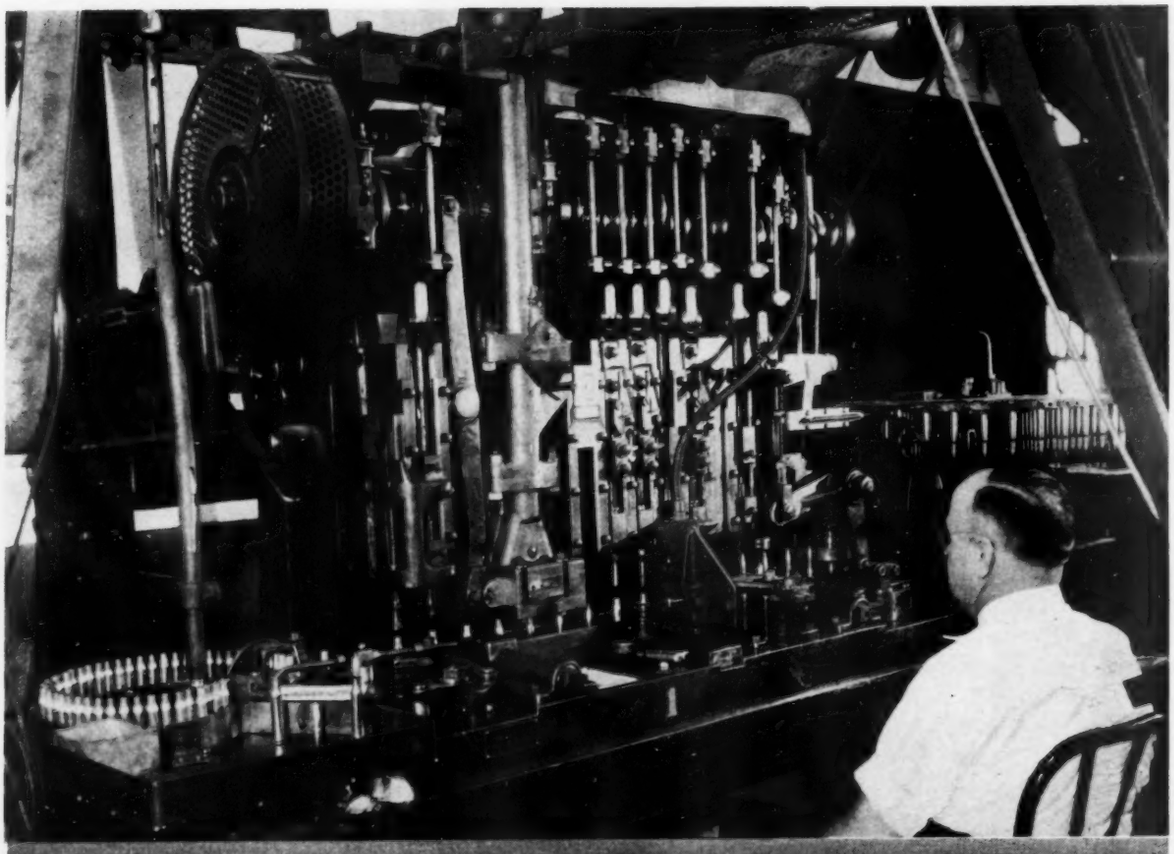
Samplings for proof tests are of two kinds. A certain number of cartridges is taken from daily production runs in order to make sure that the manufacturing standards are being maintained. In addition, samplings of about one percent are made for final acceptance tests. The stringent proof tests include those for accuracy, velocity, waterproofing, pressure, hang-fire, and in the case of the armor piercing bullets, for penetration.

Besides the proof tests, functioning tests are made by firing in a standard machine gun.

Target Test for Accuracy

Accuracy is determined by firing through craft paper targets at 600 yards. After the target has been located ten cartridges are fired. The target is then laid out with lines representing the extreme horizontal and vertical locations of the bullet holes. These lines determine the center of fire from which is determined the mean radius, that is, the average distance of each hole from the center. Accuracy within a small mean radius is required.

Velocity is determined by means of a Boulenge chronograph. Shots are fired on a 150-yd. range with electrical contacts 78 ft. apart. The impulses set up by the interruption of the electrical circuits by the bullet are transferred to the chronograph room



In the loading machine, cases are fed from the left-hand side, and filled with powder. After the bullet has been inserted, it is fastened by crimping the mouth of the case into the cannelure groove. Cartridges are painted on the nose and dried in the circular rack at the right

which is arranged with a switchboard so that any instrument may be connected with any target range. Provision is also made to connect the circuit with the Arsenal laboratory where the chromograph may be calibrated against an oscilligraph. The test for moisture proofing consists in soaking cartridges 24 hours in $1\frac{1}{2}$ in. of water and then firing them in comparison with dry ammunition.

Copper Plug Measures Pressure

For the pressure test a small hole about $\frac{1}{8}$ in. in diameter is drilled in the side of the cartridge case and covered with a piece of Scotch tape to prevent the powder from escaping. Into this hole a small plug is placed which acts as a piston and above it is placed a copper cylinder of approximately the same diameter. The cartridge is loaded into a test barrel with the plug held securely downward by means of a screw jack. When the cartridge is fired the pressure of the exploding powder is measured by the compression of the copper cylinder. For these tests the barrels used are special so they can be adapted to universal firing stands in any range without the use of special equipment. These barrels are carefully checked for finish and accuracy by means of the borescope and star gage.

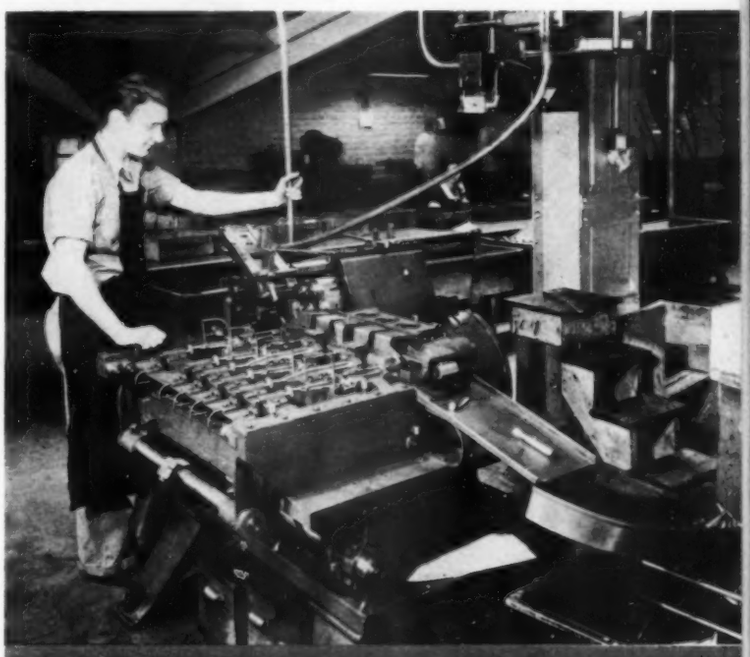
Since some machine guns are fired through the path of the propeller blade by means of synchronizing devices, the ammunition used must be carefully guarded against hang-fire in order to insure accurate timing and to prevent damage to the propeller blade. In the actual mechanism for synchronous firing, the machine gun is geared to the airplane propeller shafts in a four-to-one ratio. In the proving test, this mechanism is duplicated, except that a steel disk about 3 ft. in diameter is substituted for the propeller. After securing a "zero" mark with the disk stationary, the mechanism is started by means of a small electric motor and a blast of shots is fired with the wheel spinning. The grouping of shots on the disk indicate whether the firing is uniform. If they are beyond the specified limits the entire lot is discarded for aircraft service. A new method under development for detecting hang-fires amplifies the electrostatic charge generated by the travel of the bullet through the barrel and transmits it to a revolving drum.

Penetration tests for armor-piercing bullets consists in firing them through a thick homogeneous armor plate. This plate is placed in a tunnel so that fragments may be reclaimed and inspected. Not only is the degree of penetration examined, but the various ways in which the hard core may be broken have been classified. For instance, a bullet may or may not carry a button or broken fragment of the plate ahead of it upon striking. These various details are carefully recorded.

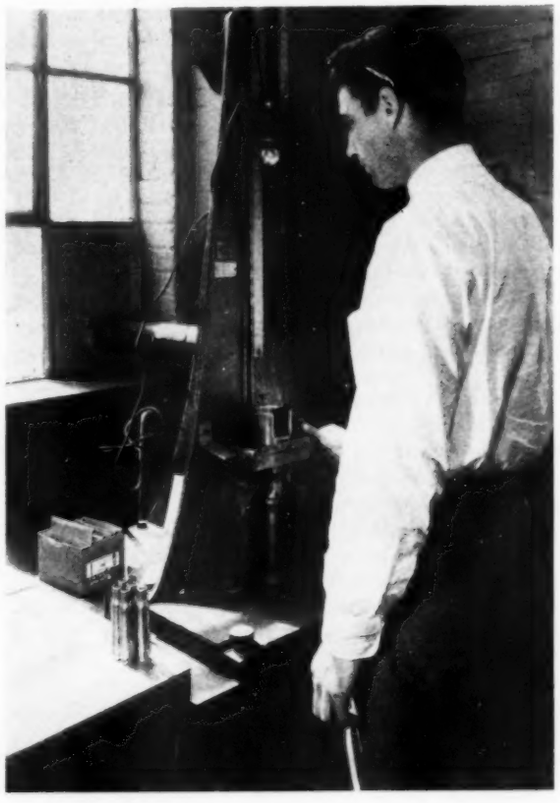
Tracer bullets are sent to the Aberdeen proving ground for their final check for accuracy and length of trace.

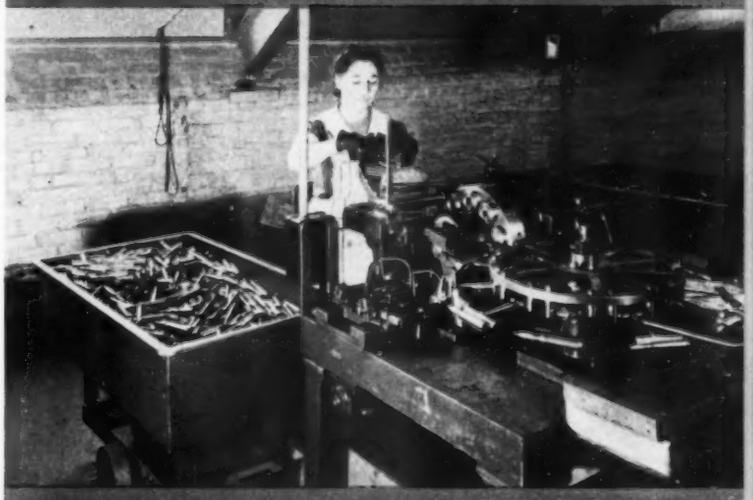
Thus it will be seen that every precaution is taken to maintain quality in the vast quantities of small arms ammunition now being turned out at Frankford. In addition these proving tests suggest improvements in the ammunition and very often in the functioning of the gun used to fire it. With increased emphasis being placed on aerial warfare, the precision and striking power of the cal. 0.50 cartridge is of vital concern.

Frankford Arsenal is considered a model plant for the manufacture of small arms and is constantly simplifying its production tools, equipment and mechanism. These refinements operate to increase productive capacity of certain sequential operations.



Dimensional inspection is speeded through the use of machines such as this. Cases not conforming to size are automatically rejected





Completed cartridges are inspected automatically. The cylindrical drum takes care of dimensional gaging while the radial arms are counter-balanced to do the weighing

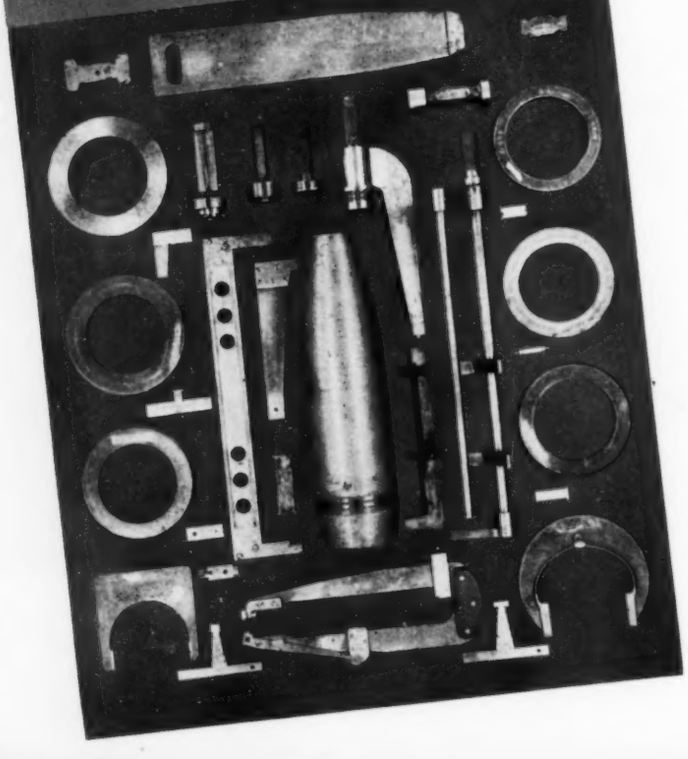
Primers are tested by dropping a steel ball on them while the cartridge case is held in a fixture. An electromagnet is adjusted vertically to release the ball at various heights

One Gage Instead of Many

An electric device eliminates many of the gages formerly needed for shell inspection

A master block is used to set tolerance limits in an electric gage. When the shell is placed in this position signal lights indicate whether all outside dimensions are correct. With this set-up few fixed-size gages are needed

During the World War gaging was a time-consuming procedure that formed a bottleneck in shell production. The gages below give an idea of what was needed



INSPECTION of shell bodies has progressed a great deal since the hectic days of 1917 when gages for munitions manufacture were almost worth their weight in gold. Gages are scarce today for the amount of production to be inspected, but gaging methods are much improved, much faster and far more accurate than they used to be.

In contrast, we will recall the methods used in inspecting shells during the World War and compare them with what modern, aggressive shell manufacturers are doing.

By the old procedure, the shell body came into the machine shop as a rough forging, the general dimensions of which were inspected with fixed-size gages—a paddle gage for checking the cavity, snap gages for the major diameters and a length gage for overall length.

Throughout the machining processes occasional checks were made to ascertain the consistency of machine adjustment and tool contour. This was done also by means of fixed-size gages, including snap, plug, profile and length gages, thread plugs for fuze seats and goose-neck gages for forging thicknesses at the bottom of the cavity. Several gages also were used in the shop to check concentricity. Furthermore, each shell body was carefully weighed before leaving the shop because weight specifications are always rigid.

On leaving the shop, machined shell bodies were cleaned and carried on hand trucks to final inspection. Final inspection has often been the real bottleneck of shell production—chiefly because of the tedious nature of the operations involved. Each inspection team usually consisted of five men working at long inspection tables.

Working diligently this team rarely checked more than 2,500 75-mm. shells in a fatiguing eight-hour day. Obviously, gage replacement under such a program was an item of considerable expense, for fixed gages in constant use soon went undersize.

The same five-man team using modern gaging equipment will now inspect 5,000 shell bodies in an eight-hour day (just twice as many as under the old method) with greater accuracy and less fatigue. Every critical dimension of every shell body is inspected instead of the partial inspection of some dimensions by the old method.

The first inspector checks fuze seat threads with a "go" thread plug gage. This check is made on every shell body, but not by the old process. The thread plug gage now is mounted on a Rickert-Shaefer tapper, with a suitable support to guide the shell body into gaging position with a minimum of effort. An occasional check is also made manually with a "not go" gage.

The next inspector sets the shell body on the locator of a Multichek Electrigage and pushes it into gaging position. In a flash all remaining critical dimensions are checked simultaneously.

The Working of NITRIDING STEELS

CERTAIN steels can be casehardened at low temperatures, and without final quenching, by the action of a nitrogenous medium such as ammonia gas. This gas decomposes partially into nitrogen and hydrogen, and the nitrogen at the moment of decomposition combines with the alloying elements in the steel to form nitrides. These nitrides impart extreme hardness to the surface of the steel—a hardness which gradually decreases inwardly until it corresponds to that of the core.

This casehardening process is called Nitriding. Because the nitrided case is obtained at low temperature, the high surface hardness is produced with minimum warpage and distortion of the treated articles. Great wear resistance, retention of hardness at elevated temperatures, and resistance to certain types of corrosion are other properties imparted to the steel by nitriding.

Certain alloying elements, such as aluminum, chromium, molybdenum and vanadium, when used in various combinations have great affinity for nitrogen; therefore, alloy steels particularly suited for nitriding have been developed. These steels, known commercially as Nitralloy, are listed in one of the tables. Typical physical characteristics of these steels after heat-treating are given in a table.

The Nitralloy to select for a given service can best be obtained by a study of the table listing the physical properties. Nitralloy *G* and *H* are most generally used where good physical and averaging machining characteristics are desired. Nitralloy *EZ* is generally selected when easy machining properties are of paramount importance. Type *G* Modified and Nitralloy *N* are used where superior physical properties are required.

In addition to these special nitriding steels, others may be nitrided when exceptionally high core hardness or other special properties are desired. These are given in one of the tables. Data for Nitralloy *N* are included since this steel possesses a high core hardness after nitriding. Nitralloy *N* and steel No. 2 are the ones most commonly used. The latter is known commercially as Nitrard when intended for nitriding.

ALLOYING ELEMENTS

The aluminum and chromium form nitrides which at the nitriding temperature precipitate from solid solution in such a way as to increase the hardness greatly. This precipitation occurs along the slip planes of the metal, resulting in a keying action which accounts for the increase in hardness. Nickel strengthens and toughens the case with a moderate decrease in casehardness. It is used particularly for its effect on the core where great increase in hardness provides better support for the case.

In so far as the core is concerned, the following definite effects are produced by nickel, chromium and molybdenum.

Nickel—The effects of this element are:

1. Raises the core strength without sacrificing ductility.
2. Retards the critical cooling rates, thus permitting slower quenching rates during normalizing.
3. Reduces grain growth.
4. Greatly increases the core strength during nitriding when present in combination with aluminum. This is believed to be a precipitation hardening effect.

Chromium—The effects of chomium are:

1. Raises the ultimate strength, hardness and toughness.
2. Decreases the critical rate of transformation.
3. Promotes a better distribution of the carbide phase.
4. Minimizes grain growth.

Molybdenum—The effects of this element are:

1. Raises the ultimate strength, hardness and toughness.
2. Minimizes grain growth.
3. Broadens the range of permissible heat-treating temperatures.
4. Reduces susceptibility to temper brittleness.
5. Improves machinability.

Although a high-sulphur nitriding steel can be used to advantage whenever free machining is demanded, and when maximum impact properties are not necessary, this element has been largely replaced by selenium. Nitralloy *EZ* represents such a steel.

Typical uses of the nitriding steels and recommendations regarding corrosion are listed in one of the tables.

This section was made possible through the cooperation of the following companies:

Abrasive Company
Allegheny Ludlum Steel Corporation
American Society for Metals
Atlas Steels Limited
Bethlehem Steel Company
Camden Forge Company
Carboloy Company, Incorporated
Cleveland Twist Drill Company
Copperweld Steel Company
Continental Machines, Incorporated
Crucible Steel Company of America
Eastern Machine Screw Corporation
Firth-Sterling Steel Company
The Geometric Tool Company
Greenfield Tap & Die Corporation
C. I. Hayes, Incorporated
E. F. Houghton & Company
Lindberg Steel Treating Company
McKenna Metals Company
Metlab Company
Morse Twist Drill & Machine Company
National Twist Drill & Tool Company
Nitralloy Corporation
Norton Company
Ontario Research Foundation
Queen City Steel Treating Company
Republic Steel Corporation
Simonds Saw & Steel Company
Socony-Vacuum Oil Company, Incorporated
The Texas Company
Timken Roller Bearing Company, Steel and Tube Division
Vanadium Alloys Steel Corporation
Vascoloy-Ramet Corporation
Wesley Steel Treating Company

PREPARATION FOR NITRIDING

Nitralloy should be heat-treated to produce a sorbitic structure prior to nitriding. Brinell hardness should be 225 to 260 for most purposes.

Bar stock is generally purchased in the heat-treated condition, and has the required sorbitic grain structure. Cold-rolled bar stock is seldom used, but if so it should be heat-treated to produce the required sorbitic grain structure and the desirable machinability characteristics.

Stock need not be heat-treated prior to making forgings since they have to be heat-treated after forging to refine the grain structure and to make them machinable. Forging temperatures of 1,950 to 2,200 F. are recommended. After forging, heat to 1,700-1,750 F., and hold at that temperature for one hour for each inch of maximum thickness. Thin sections should be quenched in oil, while it is best to quench thick sections in water. Subsequent drawing at 1,150 to 1,350 F. for four hours, depending on the thickness, will produce a sorbitic structure with a Brinell hardness from 225 to 260 which will be suitable for machining and nitriding.

After machining and before nitriding internal stress in forgings as well as parts made from bar stock, resulting from heat-treatment and machining, can be relieved by drawing at 1,100-1,300 F. Light finish machining and grinding operations can be performed after this sub-critical anneal without causing strains that promote warpage or distortion during nitriding.

In preparing parts for nitriding, all sharp edges must be rounded and suitable fillets used to avoid any tendency toward chipping, flaking or spalling after the hard nitrided case has been applied.

Surfaces to be nitrided must be bright and clean—free from scale or oxides, dirt, and grease.

Decarburized surfaces resulting from forging, hot-rolling or subsequent heat-treatment must be removed prior to nitriding. Many users allow $\frac{1}{64}$ in. of a side, or $\frac{1}{32}$ in. of the diameter, to make certain of the complete removal of decarburized surface when machining the parts. Tool wear can be reduced by sand-blasting the heated parts before machining.

Decarburization resulting from heat-treatment may be held to a minimum by the use of a salt bath for heating to high temperatures and a lead bath for low temperatures.

Certain portions of articles often have to be protected against nitriding; for example, threaded sections. These can be kept soft by tinning, soldering or nickel plating. The solder should be 80 parts lead and 20 parts tin. Tin and the alloy of lead and tin melt at a lower temperature than that used for nitriding; however, ample protection is provided by the thin layer that is held to the article by surface tension. Too much of the protective agent may cause the excess amount to drop on articles at points where protection is not desired.

Tinning may be done by elec-

TYPICAL APPLICATIONS OF NITRIDING STEELS

- Aviation engine parts:
  - Cylinder barrels
  - Knuckle pins
  - Reduction gears
  - Spacers
- Ball races
- Ball studs
- Bearings, rollers, etc.
- Blades for pumps
- Boring bars
- Burnishers
- Bushings
- Calculating machine parts
- Cam and thrust bearings in motion picture machines
- Cams
- Camshafts
- Chain links and pins
- Chuck parts
- Connecting rods
- Conveyer chains
- Crankshafts
- Crosshead pins
- Cylinders
- Cylinder barrels
- Cylinder liners
- Die casting dies and cores
- Diesel engine fuel injector and pump parts
- Ejector pins
- Fan blades
- Film perforators
- Fuel pump plungers and bushings
- Gages
- Gears
- Gudgeon pins
- Guides
- Housing nuts (4000–5000 lbs. each)
- Hub liners
- Index catches
- Index chucks
- King pins
- Knuckle pins
- Locomotive shoes and guide bars
- Main rod blocks
- Mandrels and rings
- Needle guides
- Needle valves and seats
- Nozzles
- Padlock shackles
- Pinions
- Pinion shafts
- Piston pins
- Piston rings
- Piston rods
- Pistons
- Pintles
- Pivots (scale or clock)
- Plug gages
- Plungers
- Pump rotors
- Pump shafts
- Pump sleeves
- Push rods
- Racks and pinions
- Ratchets
- Retaining rings
- Ring gages
- Rockers
- Rollers
- Rubber rolls
- Scale balances
- Scale blocks
- Seal ring (refrigerator)
- Seaming rolls
- Seats for valves
- Sectors
- Shackle bolts
- Shafts
- Slide valves
- Sockets
- Spindles
- Splines, spline mandrels
- Sprockets
- Steering worms
- Stripper plates
- Studs
- Tappets
- Thread cleaners
- Thread guides
- Thrust washers
- Tie rod bolts
- Tinsel rolls
- Timing gears
- Typewriter parts
- Valve gages
- Valve disk rings
- Valve seat rings
- Valve sleeves
- Valve stems
- Valves, steam
- Water pump shafts
- Wear plates
- Weaving arbors
- Wire draw plates
- Wire forming rollers
- Wire guides
- Worms
- Wrenches
- Wrist pins
- Yoke nuts

NOTE: Nitrided steel is not adapted for use in mineral acids, such as sulphuric and hydrochloric. It is extremely resistant to alkali, atmosphere, crude oil, natural gas combustion products, tap water, and still salt water. It is slightly attacked in aerated salt water and under alternate wetting with salt water and drying.

MOST COMMON TYPES OF NITRALLOY STEELS

	Nitralloy 125 (Type H)	*Nitralloy 135 (Type G)*	*Nitralloy 135 Modified, Aircraft Specifications*	*Nitralloy N*	*Nitralloy 230 (Alamo)*	*Nitralloy EZ (Type G with Se)*
Carbon	0.20–0.30	0.30–0.40	0.38–0.45	0.20–0.27	0.25–0.35	0.30–0.40
Manganese	0.40–0.60	0.40–0.60	0.40–0.70	0.40–0.70	0.40–0.60	0.50–1.10
Silicon	0.30 max.	0.30 max.	0.30 max.	.....	0.30 max.	0.30 max.
Chromium	0.90–1.40	0.90–1.40	1.40–1.80	1.00–1.30	.....	1.00–1.50
Aluminum	0.90–1.40	0.90–1.40	0.95–1.35	1.10–1.40	1.00–1.50	0.75–1.50
Molybdenum	0.15–0.25	0.15–0.25	0.30–0.45	0.20–0.30	0.60–1.00	0.15–0.25
Nickel	.....	.....	.....	3.25–3.75	.....	.....
Selenium	.....	.....	.....	.....	.....	0.15–0.25

trolysis or hot dipping. A plating of 0.0005 in. will protect the parts and will not run. For hot dipping the part is dipped into molten 60 percent lead 40 percent tin alloy. The flux used is

Hydrochloric acid ....500 cc
Water .....250 cc
Ammonium chloride...15 grams

Add scrap zinc until no further action takes place. Parts to be tinned should be entirely free from rust and scale. Proceed as follows: Clean part to be protected, apply flux, and dip part into molten metal to the required depth. Remove excess of tin with wire brush.

Another method of protection is to use a mixture of six parts brown tin oxide (stannous oxide) and one part of glycerine, and add a few drops of fluxing acid. The parts are cleaned and heated, and the above mixture is applied with a brush to those portions of the work which are to remain soft. After painting, the parts are dried at 400 F. and the protected areas wrapped in thin aluminum foil. A commercial paint known as Sel-Nite gives satisfactory results.

Parts can also be protected from hardening by nickel plating. This method has the advantage that nickel does not melt at the nitriding heat, and there is no danger of contaminating other work in the nitriding container. The ordinary commercial nickel plating will not answer, and it is necessary to proceed in the following manner: Clean and copper-strike the areas to be plated. Nickel plate with a solution of one-third single nickel salt and two-thirds double nickel salt. Hold for about 20 min. in a still plating tank. In order to secure satisfactory protection it is necessary to have a compact solid plate of not less than 0.0005 in. thick. This can be obtained with about two volts, the solution being at room temperature.

High chromium and austenitic steels, such as listed in the second table on this page, require special treatments prior to nitriding. They consist of (1) treating with hydrochloric acid; (2) light etching in 10 percent sulphuric acid, rinsing in water, and immersing in a copper cyanide plating bath to give a coating of 0.00001 in. of copper; and (3) immersion in a boiling solution of cadmium orthophosphate. After the pretreatment, the steels are nitrided in the same manner as the Nitralloy steels.

WELDING

The welding of Nitralloy steel can be divided into two categories: (1) Where Nitralloy is welded onto a steel of different composition and the surface hardness of the weld is unimportant. (2) Where the weld is part of the working surface, and will subsequently be nitrided.

In the first case, standard methods of welding such as electric resistance butt welding, electric arc welding, and oxy-acetylene welding may be employed. Ordinary electrodes and welding wire may be used. Care should be taken to ensure a homogeneous weld.

In the second case, where the weld is part of the working surface, it is essential that the weld be of Nitralloy composition.

With electric arc welding, even when the Nitralloy electrodes are used, a weld is obtained which, owing to heavy losses of aluminum and

NITRIDING STEELS WITH HIGH CORE HARDNESS

Steel No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*Nitralloy N*
Carbon	0.53	1.50	1.33	0.77	1.20–1.30	1.04	0.37	0.25
Manganese	0.34	....	0.28	0.24	.....	....	0.34	0.55
Nickel	....	....	0.55	....	.....	....	0.23	3.54
Cobalt	....	....	3.08	....	.....	....	....	....
Chromium	3.65	12.11	13.31	3.83	1.00–1.25	1.25	4.92	1.11
Molybdenum	0.51	0.94	0.81	8.63	.....	1.33	1.32	0.30
Tungsten	....	....	....	1.35	4.75–5.25	0.51	....	....
Vanadium	0.74	0.94	....	1.01	0.15–0.25	0.25	0.44	....
Silicon	....	....	....	....	.....	....	1.06	....
Aluminum	....	....	....	....	.....	....	....	1.30

NOTE: Austenitic steels are commonly used for exhaust valves in aircraft motors. The composition most commonly used in this country is 0.45C, 14.00Ni, 14.00Cr, 2.50W, and 0.30Mo. The usual practice is to treat the valve with 50 percent hydrochloric acid and then nitride at 1,000 F. for 50 hours. Other steels for these valves, as well as aircraft engine cylinder liners contain 17 or 18 percent chromium and from 2 to 9 percent nickel.

NITRIDING DATA

Steel No.	*Nitriding temp., F.*	*Nitriding time, hr.*	*Vickers hardness, 10 kg. load*	*Case depth, in.*	*Core hardness, Rockwell C*
1	975	72	975	0.018	47
2	1000	48	1150	0.012	59
3	1000	72	970	0.012	50
4	1000	72	1400	0.015	63
5	1000	48	925	0.008	56
6	1000	48	975	0.018	47
7	900	48	1100	0.014	43
Nitralloy N	975	35	1064	0.016	44

Nitralloy *N* is included since this steel possesses a high core hardness after nitriding. Nitralloy N and steel No. 2 are the most commonly used when high core hardness is required. The latter is known commercially as Nitrard.

chromium, cannot be satisfactorily nitrided; therefore, other methods of welding should be employed. However, in the fabrication of rings and hollow cylinders the electric resistance butt welding process gives satisfactory results, the usual precautions as regards temperatures and pressure being taken.

In oxy-acetylene welding fairly satisfactory results may be obtained with a neutral flame and using a flux and Nitralloy welding wire.

Generally speaking, the atomic-hydrogen welding gives the best results, and Nitralloy wire should be employed for any necessary filling.

Whatever method of welding is employed, the welded parts must be heat-treated after welding and before machining and nitriding.

EQUIPMENT FOR NITRIDING

Nitriding furnaces may be of the batch, semi-continuous or continuous types wherein the temperature in the nitriding container can be automatically maintained uniform between 930 and 1,000 F. The first two types are in general use in this country. A typical batch-type furnace and nitriding equipment used are shown in one of the drawings. Standard furnaces already in use for regular heat-treating can be adapted for use with the nitriding process.

Special furnaces increase the speed of the process, are more convenient to operate and facilitate handling of the containers in which the parts are nitrided. One consists of a cylindrical furnace having an inside chamber integral with the furnace. The cover fits into a ring on top of the furnace and a gas seal is obtained by filling the ring with oil. A fan is placed in the bottom of the furnace to affect gas circulation.

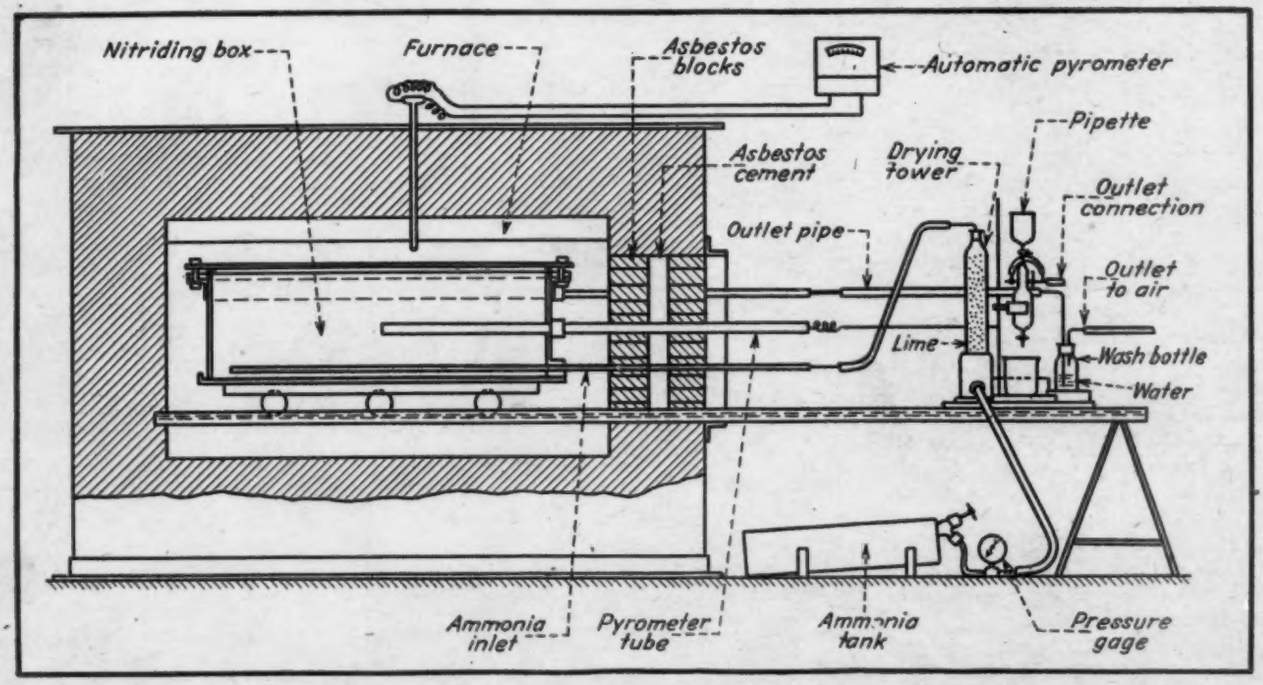
In other types of modern nitriding equipment, the electric furnace shell is movable and the hearth with the containers, piping, etc., stationary, thus minimizing the chance of leaks in the system. On completion of the nitriding cycle the furnace shell is moved over to the other end of the hearth where another loaded container is waiting. Considerable economy in current and length of time in reaching the nitriding heat is effected by this arrangement.

In another type on the same principle, the furnace shell, on completion of the nitriding cycle, is lifted by means of a hoist and placed on another hearth containing parts to be nitrided. In this type of nitriding installation the work is placed in a rack made of nickel rods fastened to the hearth, and a bell-shaped cover whose edges extend outside the furnace and dip into an oil trough, is placed over the work. All piping is stationary.

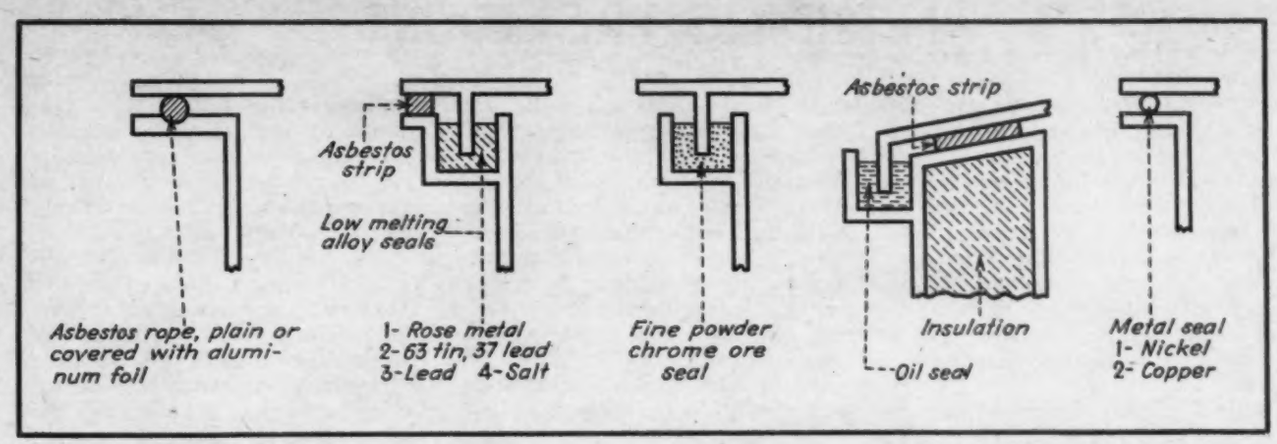
TYPES OF CONTAINERS

The parts to be nitrided are placed in a gas-tight box, equipped with inlet and outlet tubes for the circulation of the ammonia gas. The inlet tube is located in a lower corner and the outlet at the opposite upper corner. Through the center projects a protection tube for the thermocouple used for checking temperatures inside the box.

The material from which the box is made is important because the hot ammonia gases will in time permeate the metal of the container, causing excessive ammonia consumption and unsatisfactory hardening. The following materials are recommended for nitriding boxes: Nichrome or any of the high-nickel-chromium heat-resisting alloys, Inconel, pure nickel or nickel-clad steel. Boxes can be made from steel, but should then be enamelel on the inside.



Typical arrangement for nitriding equipment includes sealed containers for the parts to be nitrided, precise temperature control and accurate ammonia-gas control apparatus



The nitriding container must be sealed to prevent influx of air, which prevents proper hardening of the parts

Boxes of the latest type have covers designed so that they can be opened and closed without disturbing the packing material and quickly made gas-tight. Typical seals are shown in one of the drawings.

When very large boxes are used, multiple inlet and outlet tubes must be provided and each inlet tube should be attached to a separate ammonia cylinder.

The flow of gas must be controlled in the inlet. Therefore, some regulating device must be placed on each inlet which will assure that all inlet tubes deliver the same amount of ammonia. This can be accomplished by reversing the valve now used to regulate the ammonia flow from cylinder. Specially designed boxes will be required wherever multiple inlets and outlets are used. A manifold will not be satisfactory.

AMMONIA EQUIPMENT

The tank of ammonia must be placed in such a position that the bent tube inside the tank has its open end in the gaseous atmosphere and does not dip into the liquid ammonia, that is, the cylinder is turned in the direction opposite to that found on the tag. The brass plate on one end of the cylinder should be underneath, not on top, and the front end of the cylinder should be raised and not lowered, the valve being in the position as shown in the drawing of nitriding equipment. With the cylinder in this position it is delivering ammonia gas and not liquid ammonia.

A needle valve insures the control of a steady and even flow of gas. Traces of water if present in the anhydrous ammonia can be removed by passing the gas through a tower containing lime. The inlet and the outlet tubes are made of nickel or Inconel. The inlet tube extends along the bottom of the box to the back while the outlet tube is at the front and near the top of the box.

The gas mixture from the container passes through a wash bottle to indicate the rate of flow, and give the back pressure which should be about 1 to 2 in. The gas finally passes into the atmosphere or is washed into a drain by means of a suitable baffle.

Pyrometers are inserted into both the container and the furnace. These must be calibrated periodically to give correct nitriding heats.

The gas mixture leaving the furnace consists of hydrogen, nitrogen, and undissociated ammonia. The ammonia gas is very soluble in water whereas the hydrogen and the nitrogen are insoluble. Advantage is taken of this fact in the determination of the extent of the ammonia dissociation during the Nitriding operation. The pipette shown in one of the drawings is used for making this determination. The dissociation is generally maintained at approximately 30 percent.

AVERAGE PHYSICAL PROPERTIES OF HEAT-TREATED NITRALLOY STEELS

Grade	Quench temp., F.	Drawing temp., F.	Ultimate strength, lb. per sq. in.	Yield strength, lb. per sq. in.	Elongation in 2 in., percent	Reduction of area, percent	Brinell hardness
	1750	1100	155,000	137,000	15	52	310
G	1750	1200	138,000	120,000	20	58	280
	1750	1300	121,000	103,000	23	62	230
	1750	1100	132,000	117,000	18	61	280
H	1750	1200	122,000	103,000	21	67	255
	1750	1300	102,000	85,000	26	70	225
	1700	1100	165,000	181,000	15.5	54.3	368
G Modified	1700	1200	141,000	158,750	17.5	55.8	320
	1700	1300	125,000	145,000	20.5	64.5	285
Alamo	1650	1000	147,000	105,000	19	54	285
	1650	1100	141,000	102,000	22	57	269
N	1700	1000	198,500	191,000	14	45	387
	1700	1100	145,000	130,000	21	58	302
EZ	1700	1100	139,000	67,500a	16	44	293
	1700	1200	125,500	90,000a	17	45	255

a Proportional limit instead of yield point.

Following are core properties of Nitralloy *N* after quenching in oil at 1,650 F. and drawing at 1,200 F.: Before nitriding — Ultimate = 132,400 lb. per sq. in.; yield = 114,600 lb. per sq. in.; elongation = 22 percent; reduction of area = 59 percent; Brinell hardness = 277. After nitriding — Ultimate = 190,300 lb. per sq. in.; yield = 180,000 lb. per sq. in.; elongation = 6 to 15 percent; reduction of area = 43 percent; Brinell hardness = 415.

Physical properties of Nitralloy *G* drawn at 1,100 F. and nitrided 90 hours at 900 F.: Ultimate = 159,000 lb. per sq. in.; yield = 129,000 lb. per sq. in.; elongation = 5 percent; reduction of area = 16 percent.

Physical properties of Nitralloy *G* drawn at 1,300 F. and nitrided 90 hours at 900 F.: Ultimate = 123,000 lb. per sq. in.; yield = 98,000 lb. per sq. in.; elongation = 8 percent; reduction of area = 20 percent.

Lower hardness before nitriding can be obtained by tempering at a higher temperature than 1,200 F. in order to promote machinability without affecting the core hardness.

NITRIDING PROCEDURE

In commercial nitriding the parts are subjected to the action of the ammonia gas at temperatures ranging from 930 to 1,000 F. The higher the nitriding temperature, the lower the hardness obtained and the deeper the penetration. However, if for any reason a soft case is obtained at temperatures such as 1,100 to 1,200 F., no increase in that hardness can be obtained by subsequent nitriding at a lower temperature.

In this country, the single treatment at 930 to 1,000 F. is common practice. However, various nitriding cycles have been tried. One of these uses a temperature of 950 to 1,000 F. followed by a nitriding temperature of 1,150 to 1,200 F., whereby it is claimed that a tougher case is produced than if only the lower temperature is used. A three-stage cycle has been used in Europe—the parts are first treated at 930 F., then at 1,100 to 1,200 F., and finally back to 930 F.; a greater case depth with a reduction in the nitrogen concentration together with decreased surface brittleness is claimed. Tests have proved these cyclic treatments to be unsatisfactory.

The average nitriding cycle employed at present is 48 to 60 hours; however, it may vary from less than 10 hours up to 90 hours, depending upon the thickness of the article and the case penetration desired. Short-time cycles would be used on light thin sections where a deep penetration of cases must be avoided or where only a skin hardness is desired.

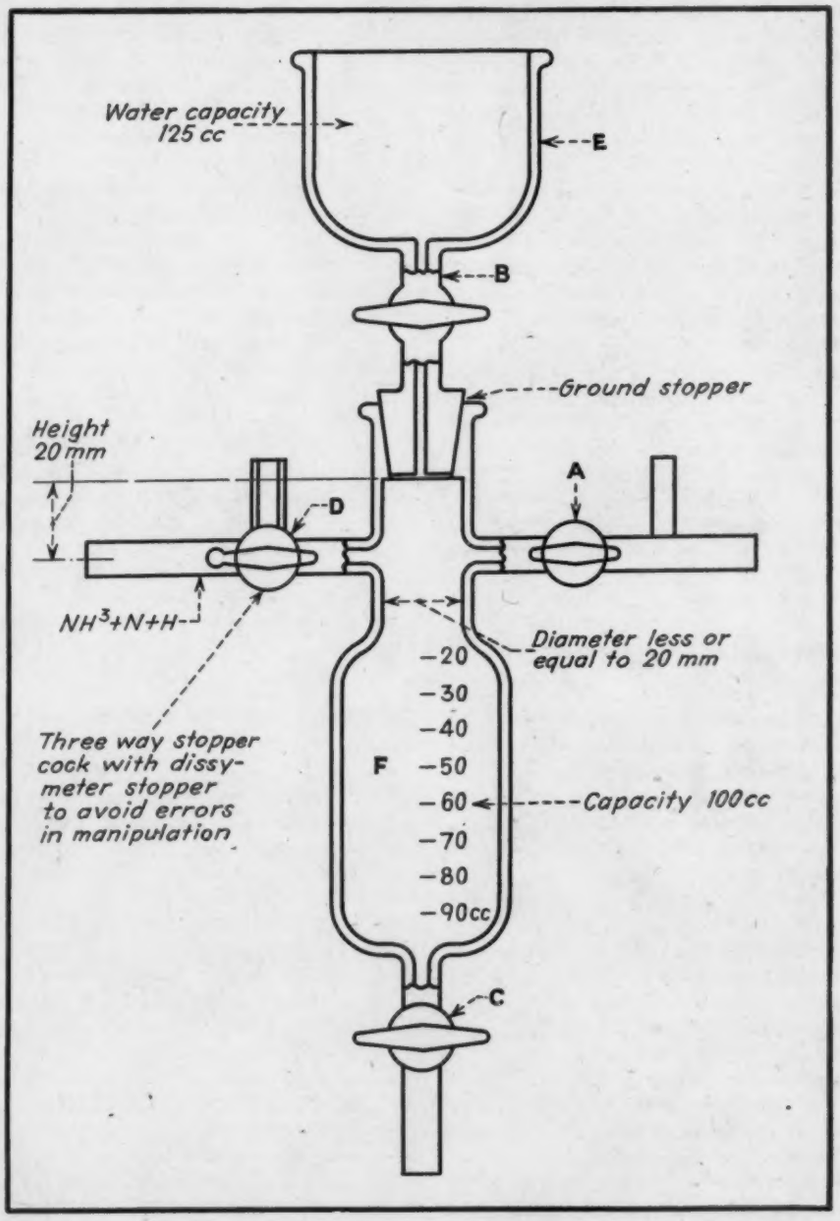
The case produced by the full 90-hour nitriding treatment is approximately 0.031 in. deep. An average 48-hour nitriding cycle at 950-975 F. should give a case penetration of 0.020 in. and a surface hardness of 1,000 to 1,100 diamond Brinell as determined by the Vickers testing machine,

The parts to be hardened are placed loosely in the container and separated from each other by nickel wire or nichrome screening, for free gas circulation. Ordinary steel or cast iron should not be used for racks or supports. The nitriding containers must be clean and free from scale or foreign matter. The gas inlet and outlet tubes should be clean. Careful handling of the articles to be nitrated must be exercised in order not to chip or crack the enamel if the containers are so lined. The cover is then placed in position and the ammonia turned on.

The power is now turned on and the pyrometer couple inserted into the container. The time of the nitriding period should be taken from the point when the chamber pyrometer shows the required nitriding temperature.

During the early stages of the heat, the needle valve on the ammonia cylinder is regulated so that approximately the right flow of ammonia is obtained by observing the bubbling through the wash bottle in the outlet line. At this time the dissociation of the ammonia should be checked by the pipette.

At the start of this determination, stopcocks *A* and *B* are closed while *C* is open. Stopcock *D* is turned so as to admit the gas mixture from the container into the graduated chamber. After the air has been expelled, stopcock *C* is closed and *D* is turned so as to by-pass the gas mixture. Reservoir *E* is filled with water, after which the stopcock *B* is opened to admit the water into the graduated chamber *F*. The water immediately absorbs the ammonia and the atmosphere above this solution contains the insoluble hydrogen and nitrogen. The water solution should reach approximately the 30 cc. mark, indicating 30 percent

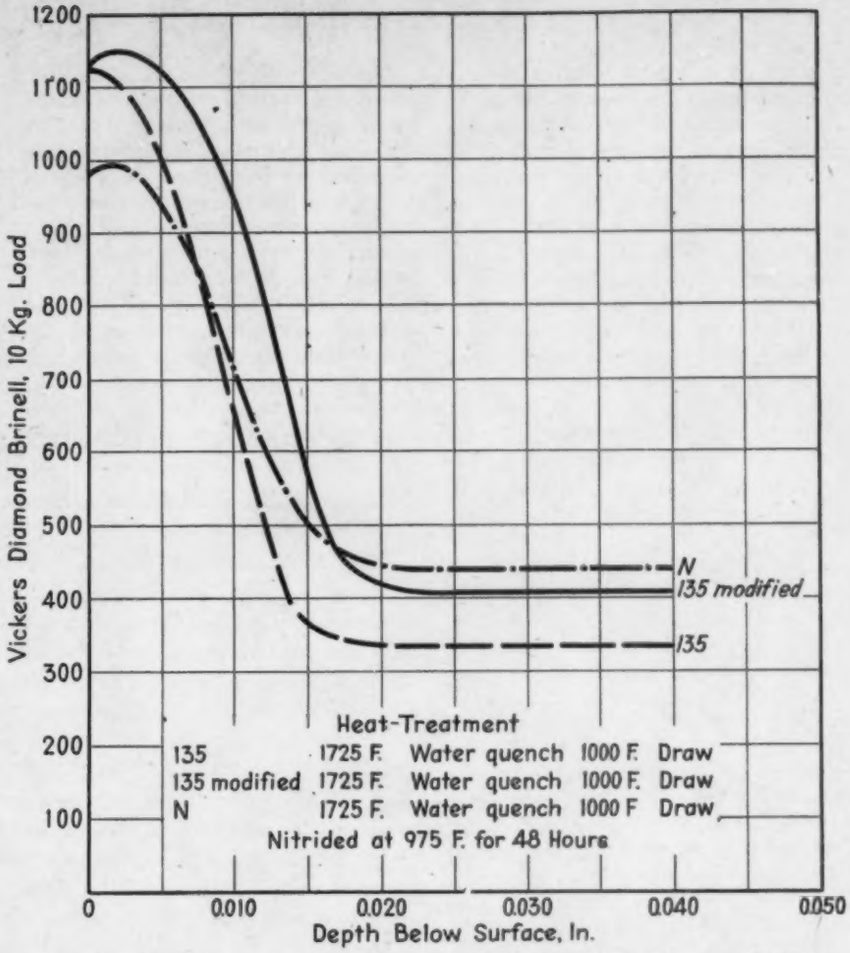


Dissociation of the ammonia gas must be checked during the nitriding process. This pipette was designed for that purpose

of dissociation. If the water level falls below that, say 40 cc., turn on more ammonia. Anywhere between 20 cc. and 30 cc. on the pipette shows correct dissociation inside the furnace. Low dissociation does no harm, but wastes the ammonia. After the flow of gas and dissociation is regulated satisfactorily, the operation requires little attention beyond an occasional checking of the dissociation.

In case the current should fail, or the temperature of the furnace should go down, keep the ammonia running, but do not count that time when the temperature falls below the desired point as part of the nitriding period. After the chamber has been at the nitriding temperature for the required number of hours, the current is turned off and the ammonia is allowed to flow through the chamber until the temperature falls to approximately 700 F. The ammonia is then shut off and the chamber allowed to cool until the work can be handled. In this case the inlet and outlet tubes are connected together after the shut-off of the ammonia by a short length of rubber tubing so that air will not leak into the chamber. This cooling period should not be hastened by abrupt air cooling or quenching in any way, or the best results may not be obtained.

If during the running of the heat, the ammonia supply fails either through exhaustion of the cylinder without a replace cylinder being available or through breaks in the tubing, the furnace should be shut down.



These curves show depth hardnesses obtained with Nitralloy N, 135 and 135 Modified. Removal of the somewhat brittle layer from the surface after nitriding gives the greatest surface hardness

OPERATIONS AFTER NITRIDING

After nitriding, the parts will be free from distortion or irregular growth exactly in proportion to the care exercised in nitriding and in carrying out the recommended practices for forging, heat-treating and stress-relieving.

If cooled properly the nitrided parts should show no discoloration but a silvery gray appearance which can be brightened up somewhat by a buffing action if desired. If some of the parts show discolorations and bright hues, this is probably the result of exposing the nitrided parts to the air before they are properly cooled down. Generally speaking, however, the hardness is unaffected. If, on the other hand, the discoloration occurs because of an air leak during the nitriding operation, it will be found that full nitriding has not occurred and soft areas and non-uniform hardness result.

CORRECTION METHODS

In cases when the strains have not been relieved, distortion may occur during nitriding. This is especially true when sections are thin, or in parts having a large diameter on one end and a comparatively long section of small diameter at the other end.

Slight warpage can be eliminated by grinding. Parts warped excessively may be straightened after heating them to 1,000–1,200 F. Parts can also be straightened cold, but this is not generally recommended, because of the danger in cracking the nitrided case.

All straightening should be performed with caution in order not to crack the case. Cracks will lead to fatigue failures when present at vital points in parts subject to stress reversals. Also, they cause failure to withstand corrosion.

Nitrided parts will show a growth or sectional increase. Allowance can be made for this in the final machining or grinding operations prior to nitriding; however, it is general practice to finish the part to the desired dimensions and then remove the slight growth by lapping or grinding after nitriding. Special grinding wheels, which are discussed later in this article, are available for finishing parts prior to and after nitriding.

The removal of 0.001 in. after nitriding removes a brittle layer and exposes a slightly harder surface. This can be observed from the graph of hardness penetration. The removal of 0.001 to 0.002 in. will not seriously affect the hardness, but obviously the more that is removed, the thinner the case becomes.

Once the changes in dimension have been determined for any part,

consistent repetition of such growth can be obtained providing surface preparation, nitriding equipment and nitriding procedure remain the same. Data presented in one of the graphs are typical of growth characteristics resulting from the nitriding procedure.

To overcome the slight variation in dimensions, various methods of artificial aging may be adopted. The following one is recommended: The parts are carefully heated to 392 F. and, after soaking for a time, dependent on their mass, are subjected to extremely slow cooling to a normal temperature. The heating, followed by slow cooling, is repeated at progressively lower temperatures at intervals of about 77 F., the final cooling being from 122 F.

HARDNESS TESTING

The hard surface produced by nitriding is beyond the usual range of hardness testing. The Brinell ball and the Rockwell diamond point result in shattering either the case or the point. The Shore Scleroscope gives readings of from 102 to 113, but the results tend to vary.

The hardness testing machines that are most commonly used for testing the hardness of nitrided steels are the Rockwell Superficial Hardness Tester (15 kg. or 30 kg. load) and the Vickers Hardness Tester (10 kg. load is most commonly used). The regular Rockwell tester using the "A" scale is also being employed using a 60 kg. load.

DENITRIDING

There are occasions when it is desirable to soften nitrided parts for the purpose of making changes in design. It has been claimed that this can be accomplished by heating the nitrided parts in a fused bath consisting of a mixture of 50 percent each of sodium and potassium chlorides at a temperature of 1,500 F., whereby a decomposition of the nitrides takes place. Softening of the case by annealing at 1,300 F. has also been recommended and will render the material machinable but the renitriding will not restore the part to its original hardness.

Neither method will produce good results. In order to insure satisfactory results the softened layer should be completely removed before renitriding. Such a procedure obviously precludes the use of these softening processes on finished articles.

Summarized precautions and recommendations are given in one of the tables.

SERVICE PROPERTIES

Nitrided steel retains its hardness at elevated temperatures. It can be heated for long periods of time at 1,000 F., and for short periods at 1,200 F. without producing any softening of the case. The case is just as hard when tested at 750 F. as at room temperature. This characteristic makes nitrided steels valuable where there is danger of faulty lubrication.

Tensile strength of the steel is affected little by nitriding because the case represents only a small portion of the cross-section of the tensile test specimens. Invariably any change in tensile strength shows an increase after nitriding, although ductility may be slightly lower. Some physical properties of these steels after nitriding are given in the footnotes of the table on page 879.

Wear resistance of these steels is exceptionally high. It is less susceptible to galling and scoring than other case-hardened and hardened steels because the nitrided case does not lose any of its hardness until heated above 750 F.,

SUMMARIZED PRECAUTIONS AND RECOMMENDATIONS

1. To insure the best nitriding results, the steel should be heat-treated so as to possess a uniformly sorbitic structure.

2. Before nitriding, the steel must be free from decarburization.

3. If freedom from distortion is of paramount importance, the internal stresses produced by machining or heat-treating should be removed before nitriding by heating to a temperature of 1,000–1,300 F.

4. Since some growth takes place on nitriding, this should either be allowed for in the final machining or grinding operation prior to nitriding or removed by lapping or by careful grinding. However, the removal of only a slight amount of the nitride case is permissible.

5. If maximum resistance to corrosion is desired, the parts should be used as they come from the nitriding container.

6. Nitrided steels of the nitralloy type should not be used where resistance to the corrosion of mineral acids is encountered or where resistance to sharp abrasive particles at high velocities is required, as in sand nozzles.

7. If straightening is required after nitriding, it should be done hot at 1,200 F., although some straightening may be done cold.

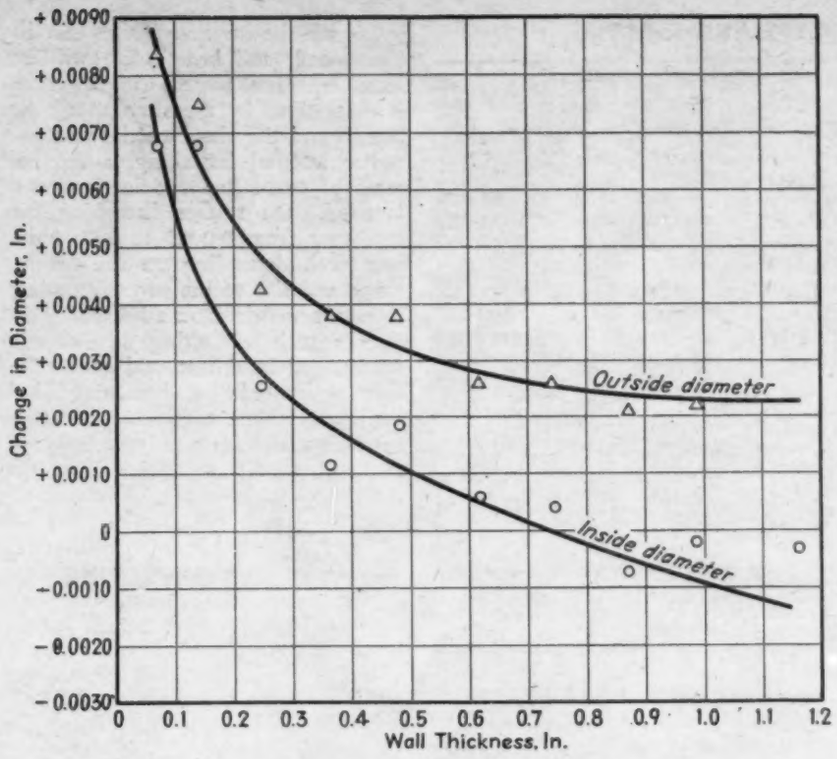
8. If maximum hardness and maximum resistance to impact are desired and the question of maximum corrosion resistance is not of vital importance, the removal of 0.001–0.002 in. of the nitrided case is desirable. The amount to be removed depends upon the original case depth. This operation will remove the more brittle and somewhat softer surface layer.

9. If nitrided articles exhibit a shiny gray surface after their removal from the container, the results should be viewed with suspicion. Invariably, the case will be shallow and below normal hardness. The articles should have a matte gray appearance, although a slight discoloration does not indicate faulty nitriding. A slight vacuum may be created within the container when the furnace is shut off and if a small amount of air enters through the gasket, the articles may show various hues such as pink, blue, or light brown. Increasing the flow of ammonia at this stage or nitriding in the presence of copper turnings will frequently prevent this discoloration. The opening of the container at too high a temperature will also cause surface discoloration.

10. Specimens that can be checked for hardness and depth of case should be included with every charge.

11. Applications requiring a high core hardness to support the case when high compressive stresses are present require nitriding steels of special analyses.

12. Although special nitriding furnaces are desirable, such equipment is not absolutely necessary. In most instances these special furnaces are constructed so that they can be used for general heat-treating purposes when not used for nitriding. The most essential point is that a furnace must maintain a uniform temperature within the nitriding container.



Parts will grow during the nitriding. The values shown here are typical of rings and cylinders. Once the growth for any part has been established, it can be duplicated on succeeding nitriding heats, providing all working and operating conditions remain the same

and retains high hardness up to 1,100 F. Therefore, nitrided steels are especially suitable for bearings. Leaded and graphite bronzes are generally used as bushings. A bronze containing 80 percent copper, 10 percent tin and 10 percent lead is suitable for most purposes. One of the most widely used applications for nitrided steels is for cylinder barrels of high-power aircraft motors, because of their resistance to wear and combustion products at elevated temperatures.

Corrosion resistance is one of the excellent properties of these steels, providing they are used as they come from the nitriding furnace. The removal of part of the case will decrease the corrosion resistance to a marked degree. It must be understood that nitrided steels cannot be placed in the same classification as stainless steels when corrosion resistance is a consideration. However, they exhibit high resistance to alkali, atmosphere, crude oil, natural gas combustion products, superheated steam, tap water, and still salt water. It is slightly attacked in aerated salt water and under alternate wetting with salt water and drying. They are not suitable for use in mineral acids such as sulphuric and hydrochloric.

Endurance against repeated stress is increased by nitriding steel; however, permissible loads are limited by the fatigue properties of the core material. Fatigue cracks in nitrided parts do not commence at the surface; therefore, small surface defects such as notches, threads and scratches are not so important as in other steels. In some instances, surface defects in the parts before nitriding will result in the starting of fatigue cracks.

Creep tests on nitrided nitralloy have shown that after 4,000 hours at 1,000 F. the extension was 0.002 in. No further extension occurred during an additional 5,000 hours at this same temperature.

Ductility of the case is indicated by the character of the impression produced by the hardness testing machine. If the impression is free of spalled edges, the case will be more ductile than one in which the edges are not well defined.

MACHINING THE NITRIDING STEELS

Nitralloy steels are heat-treated to produce the sorbitic grain structure necessary for nitriding. In this condition the Brinell hardness generally ranges from 225 to 260, but may run over 300 for special purposes.

After rough machining, the parts must be subjected to a sub-critical anneal, usually 100 F. higher than the nitriding temperature, to relieve internal stress set-up by heat-treating, rough machining and grinding. If this is not done, the parts may warp excessively during nitriding. Light machining and grinding are permissible after the anneal.

To minimize internal stress, machining cuts should not be deep and small feeds should be used. Feeds may range from 0.045 in. for roughing down to 0.004 in. for finishing, although those most commonly used are 0.015 to 0.030 for roughing and 0.005 to 0.007 for finishing. For precision boring feeds of 0.001 in. or less are used. One of the tables lists typical cutting speeds.

Some users sand- or shot-blast the parts after heat-treatment to eliminate scale, and thereby reduce tool wear.

With high-speed tools, surface cutting speeds usually run from 50 to 75 ft. per min. for heavy cuts, and from 90 to 130 ft. per min. for light cuts. Single-point tools in general use have side-rake angles of 16–20 deg., back-rake angles from 3 to 5 deg., side cutting edge angles of 10 deg., and end and side relief angles from 3 to 6 deg. Cobalt high-speed tools are generally recommended for machining forgings.

Cemented-carbide cutting tools are used for fine feeds and light cuts, with surface speeds running as high as 600 ft. per min. for very fine finishing cuts. Back rake on these tools vary from 6 to 15 deg., while side rake angles are from 8 to 30 deg. The relief angles around the cutting edge usually run from 6 to 12 deg. For ordinary work, the end cutting edge angle is usually 15 deg., while the side cutting edge angle varies from 5 to 20 deg. For interrupted cuts on lathes and planers, it is desirable to use a tool with negative back rake as great as 8 deg. in combination with 10 deg. or more side rake. Some users recommend turning tools with 6 deg. side rake and 2 deg. negative back rake. Standard tools with 12 deg. positive back rake are made in common boring

TYPICAL CUTTING SPEEDS AND FEEDS

Type of tool	Depth of cut, in.	Feed, in. per revolution: 1/128	1/64	1/32	1/16
		Surface speed, ft. per min.			
High-speed steel	1/64	120–130	105–115	95–100	.....
	1/32	110–115	96–103	84– 90	70– 75
	1/16	100–110	89– 95	79– 85	68– 72
	1/8	.....	80– 86	71– 76	63– 67
	1/4	.....	68– 72	62– 66	54– 58
Stellite-type	1/64	180–200	160–175	135–150	.....
	1/32	175–180	142–152	123–132	108–116
	1/16	150–170	130–140	115–123	101–108
	1/8	.....	118–127	105–112	91– 98
	1/4	.....	101–108	90– 96	78– 83
Cemented-carbides	1/64	450–500	400–450	350–375	.....
	1/32	400–450	350–375	320–345	.....
	1/16	365–400	330–350	290–320	.....
	1/8	.....	300–330	260–290	.....
	1/4	.....	280–300	230–260	.....

NOTES:
Light cuts and small feeds are recommended for nitriding steels to avoid setting up internal stress in the metal, which tend to warp and distort the parts during nitriding.
Most common roughing feeds are 0.015–0.030 in. per revolution, while finishing feeds are 0.005–0.007 in.
The higher speeds in this table are for free-cutting Nitralloy steels such as types *G*, *H*, and *EZ*. The lower speeds for types *G* Modified, *N* and the ones with high core hardness.

sizes for bars holding the tool at 90, 45 and 30 deg. In larger bores, the cutting edge may be leveled off slightly to 8 or 6 deg., or whatever necessary to give the desired negative back rake with the cut surface of the bore. Typical cutting tools are shown in the drawings.

Surface finish on nitriding steels when machined with cemented-carbide tools at high speeds is in many cases turned with sufficient precision that subsequent grinding is not necessary. In other cases, grinding allowances have been reduced, saving wheel wear.

Milling of nitriding steels is done satisfactorily with both high-speed and cemented-carbide cutters. Recommended cutting oils are given in one of the tables.

DRILLING

In drilling nitriding steels having a Brinell hardness around 250, best results are obtained with drills having point angles of 130–140 deg. and lip clearances as low as 5 deg. However, for the free-machining nitralloy steels, such as types *G*, *H* and *EZ*, a point angle of 118 deg. and a lip clearance of 10 deg. are recommended. Drilling speeds and feeds are listed in one of the tables.

Where the depth of the hole is equal to four or five times the diameter of the drill, oil-hole drills will help to minimize internal stress. This applies to drills $\frac{3}{8}$ in. and larger.

In drilling these steels, soluble oil, sulphurized oil, and in some cases a high-grade mineral oil are favored as a cutting fluid.

BROACHING

When these steels are properly forged, annealed, or normalized to produce correct machiniability, they may be broached with the same broaches used for other alloy steels, but with some changes in broaching speeds and feeds, and type of coolant. The cut per tooth can remain the same, but by lowering the broaching speeds internal stress will be reduced, finish will be improved, sizes can be maintained, and broach life will be increased. The average cut per tooth is determined by the strength of the broach and the shape of the part.

For internal broaching, a cut per tooth of 0.004 to 0.005 in. is recommended. On surface broaching the cuts vary from 0.0025 to 0.0035 in. per tooth depending on the length, shape and size of the part. A coolant is more beneficial than a lubricant during broaching. Cutting oils have a tendency to hold heat, and due to the friction caused by broaching, the broach becomes overheated, causing expansion and increased sizes. However, this condition will not occur if a sufficiently large volume of soluble oil is used.

TAPPING AND THREADING

Only high-speed or better grade taps are recommended for tapping nitriding steels. Nitralloy *N* and the other hard-core steels are tapped better when the cutting face of the tap has up to a 10–15 deg. hook, while the free-cutting nitriding steels are best tapped with a 10–15 deg. rake. Recommended peripheral speeds for high-speed taps are 20–35 surface ft. per min., with the lower speeds for Nitralloy *N* and those given in the table listing steels of high core hardness. The higher speeds are for Nitralloy *G*, *H*, 230 and *EZ*.

CUTTING OILS FOR NITRIDING STEELS

Operation	Hard core	Nitralloy
Grinding	50W + 1SO(F)	50W + 1SO(F)
Cold sawing, high speed	30W + 1SO	20W + 1SO
	LM	LM
Cold sawing, low speed	SM(3)	SM(3)
	LM	LM
Milling, drilling	15W + 1SO	10W + 1SO
	SM(3)	SM(2)
	LM	LM
Turning, boring	20W + 1SO	20W + 1SO
	SM(4)	SM(3)
	LM	.....
Reaming	10W + 1SO	10W + 1SO
	SM(3)	SM(1 or 2)
	LM	LM
Broaching, roughing	15W + 1SO	10W + 1SO
	SM(3 04 4)	SM(2 or 3)
	LM	.....
Broaching, finishing	SM(1 or 2)	SM(1 or 2)
Die threading, tapping	SM(1)	SM(1)

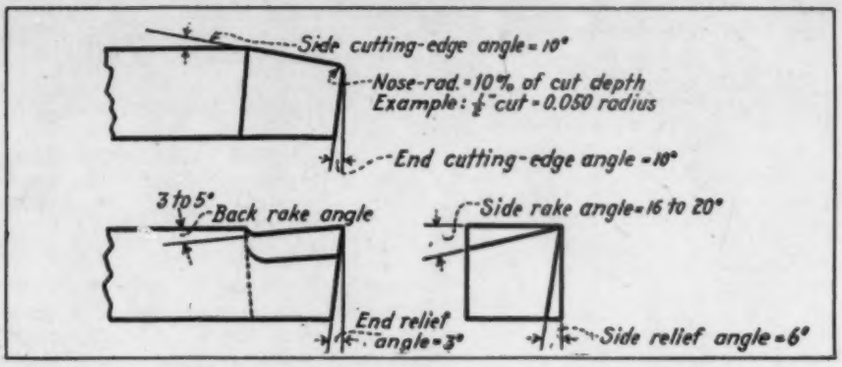
LEGEND:
W — water.
SO — soluble cutting oil.
SO(F) — soluble oil processed to free itself of grits and dirt.
SM — sulphurized mineral oil; numbers in parentheses indicate cutting strength, number 4 being the strongest.
LM — straight mineral oil.
30W + 1SO — 30 parts water plus 1 part soluble cutting oil.

When threading these steels, the chamfer or lead angle should be at least 20 deg. The feed of the threading tool is fixed by its pitch; thus, one with a pitch of 16 threads per inch must feed 0.0625 in. per revolution. Hence, a long chamfer on chasers is the only way to distribute the cut unless the thread is recut; this should be taken into consideration when the piece to be threaded is first laid out on the drawing board.

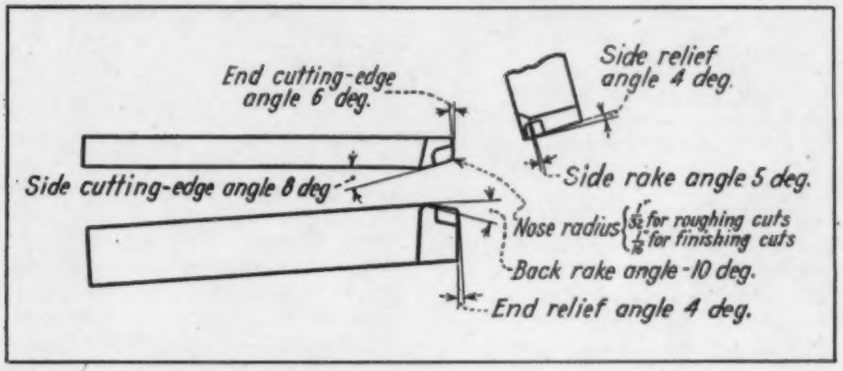
These steels, because of their alloying elements, should not be threaded at a surface speed much over half of that of regular screw stock—the higher the carbon, the lower the threading speed. The cutting edge of dies should be relatively smooth and ground with an ample hook of say 15 deg. Chasers should be reground frequently to remove the false edges and maintain proper clearances and keen edges. Frequent resharpening means less tool costs and better work. Threading speeds are given in a table.

The nature of these steels, and the necessity to minimize internal stress as much as possible during machining operations, make it desirable to have good alignment of the die and work. The die head should be given a proper and sufficient start in order to prevent cramping, tearing and taper threads. The chasers should be relatively hard, and when the threads are run on heat-treated stock, the chasers should be ordered to specifications that specify the hardness of the stock.

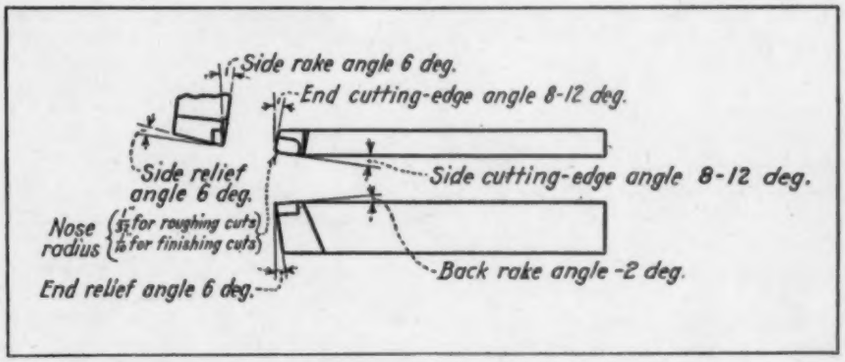
In general the following threading speeds have been found satisfactory: 8 ft. per min. for 3–7½ pitch threads; 10 ft. per min. for 8–15 pitch; 15 ft. per min. for 16–24 pitch; and 20 ft. per min. for pitches of 20 threads per inch and above. These speeds are subject to change, depending upon the cutting qualities of the material, lubricant used, and the condition of the machine and threading equipment.


Side cutting-edge angle = 10°
Nose-rad. = 10% of cut depth
Example: ¼" cut = 0.050 radius
End cutting-edge angle = 10°
3 to 5°
Back rake angle
Side rake angle = 16 to 20°
End relief angle = 3°
Side relief angle = 6°

Nitriding steels have Brinell hardness of 225-300, and can be machined the same as other alloy steels in this hardness range. Shown here are typical angle for high-speed steel cutting tools


End cutting-edge angle 6 deg.
Side relief angle 4 deg.
Side rake angle 5 deg.
Side cutting-edge angle 8 deg.
Nose radius
for roughing cuts
for finishing cuts
Back rake angle -10 deg.
End relief angle 4 deg.

Cemented-carbide tools can be used for light cuts on nitriding steels. Typical angles are shown


Side rake angle 6 deg.
End cutting-edge angle 8-12 deg.
Side relief angle 6 deg.
Side cutting-edge angle 8-12 deg.
Nose radius
for roughing cuts
for finishing cuts
Back rake angle -2 deg.
End relief angle 6 deg.

Recommended angles shown here are for carbide-tipped tools when making interrupted cuts on nitriding steels

MILLING

For these steels, milling speeds of 60–80 surface ft. per min. and feeds of 0.008–0.010 in. per tooth are commonly used for roughing cuts. The higher speeds are for Nitralloy *G*, *H*, 230 and *EZ*, while the lower ones are for Nitralloy *N* and the other hard-core steels. The finish cutting speeds are often 40 to 80 percent higher than the roughing speeds.

Recommended tooth angles are as follows: End relief angle, 3–5 deg.; clearance angle, 10–15 deg.; rake angle, 10–15 deg. The land is usually $\frac{1}{32}$ to $\frac{1}{16}$ in. wide. The clearance behind the cutting edge must be sufficient to avoid rubbing, but should not be so great as to allow the cutter to "hog in."

SAWING

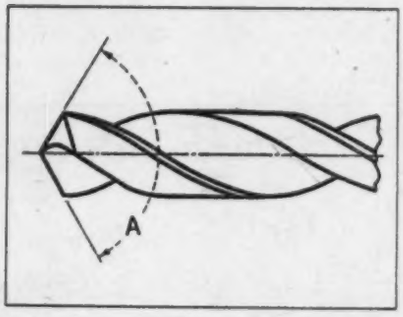
Band Saws—In sawing nitriding steels, especially high-chrome types, a hard temper saw with 8 to 14 teeth per inch, and with a raker set (one tooth to the left, one tooth straight, and one tooth to the right), should be used for pieces over ¼ in. thick. Recommended cutting speeds are 200 and 250 ft. per min. for the free-cutting and tough nitriding steels, respectively. For cutting thick sections, coarse-pitch saws should be used.

For cutting parts less than ¼ in. thick, an 18 to 32 pitch wave-set saw, operating between 400 and 1,500 ft. per min. can be used. The higher speeds are recommended for the thinner materials, especially when of Nitralloy *G*, *H*, 230 and *EZ*. In all cases, the greater the feed, the wider and heavier must be the saw to withstand the cutting pressures. The steels can be cut without a coolant.

DRILLING DATA

Size in.	Feeds, in. per rev., for the following Brinell hardnesses 225–250	250–300	Surface speed, ft. per min.[a]
1/8.....	0.004	0.003	40–50
1/4.....	0.007	0.005	40–50
1/2.....	0.010	0.008	40–50
3/4.....	0.013	0.010	40–50
1.....	0.016	0.012	40–50

[a] Speeds determined using sulphur base cutting oil.



For Nitralloy G, H *and* EZ *the point angle A should be 118 deg. For types* G *Modified, 230 and* N *use 130 deg. For nitriding steels with high core hardness an angle of 140 deg. is recommended.*

Solid-Tooth Circular Saws—These saws run from 8 to 32 in. diameter, the smaller diameters being used on milling machines and saw benches, while the larger ones are for metal cut-off machines. In general, the saw speed should not exceed 60 surface ft. per min. For Nitralloy *G, H,* 230 and especially *EZ,* the speed may be increased to as high as 90 ft. per min., while for Nitralloy *N* and the other hard-core steels speeds of 50 ft. per min. and less are often used. Teeth angles for these circular saws will vary from 8 to 15 deg. for hook or rake angles, and from 7 to 12 deg. for the top clearance angle. Recommended feeds range from $\frac{1}{32}$ to 1 in. per min.

Inserted-Tooth Saws—An inserted-tooth saw is not recommended for diameters under 18 in. They do not provide smooth cutting, because of the large tooth space required. Rim speeds recommended are 25–35 ft. per min. Hook angles for the inserted teeth vary from 10 to 15 deg., while the top clearance angles vary from 5 to 12 deg. Because of the severe cutting action of these saws, they are used infrequently.

Hacksaws—Hacksaws can be operated up to 100 strokes per minute, with feeds of 0.008 to 0.020 in. per stroke, depending upon the blade size being used. Feed pressures recommended vary between 75 and 250 lb.

GRINDING

In the annealed condition, nitriding steels resembles ordinary alloy steels and present no unusual difficulty in grinding. For grinding nitriding steels, cylindrically and surfacing before the nitriding, a wheel 36 to 46 grit aluminum-oxide abrasive is used. The wheel grade is soft and a vitrified bond employed. Silicon-carbide as the abrasive is used in some cases which can be explained by the fact that the nitriding steel in the annealed state, being quite soft and having more or less of a tendency to load the wheel sometimes, can best be ground with a silicon carbide wheel.

For cylindrical grinding after nitriding, a very high-grade commercial finish can be obtained with wheels 46 to 60 grit in soft grades, vitrified bond. The wheel speed is approximately 5,000 surface ft. per min. The work speed is about 6,500 surface ft. per min. and the table speed $\frac{1}{16}$ to $\frac{3}{32}$ in. per revolution of the work. About 0.005 or 0.006 in. stock is removed with the wheel in this operation. Inasmuch as the hardness of the nitrided piece drops off rapidly as the depth is reduced, a minimum amount of stock should be removed with grinding after nitriding. It is possible to hold this amount of stock to be removed to a very low figure because the material is practically free from any distortion in the nitriding process.

THREADING SPEEDS

Thread diam., in.	National coarse thread Surface speed, ft. per min.	Speed, r.p.m.	National fine thread Surface speed, ft. per min.	Speed, r.p.m.
1/4....	35	535	40	611
3/8....	30	306	35	357
1/2....	25	191	35	286
5/8....	25	153	35	214
3/4....	20	102	30	153
1.....	20	76	30	115
1 1/4....	18	55	25	76
1 1/2....	18	46	25	64
2.....	15	29	20	38
2 1/2....	15	23	15	23
3.....	10	13	15	19

NOTE: These cutting speeds are for annealed stock only. When heat-treated material is threaded, decrease the cutting speeds 20 to 30 percent.

If it is necessary to have a mirror finish, this can be obtained by removing 0.001 in. or so with a silicon carbide wheel of about 400 to 500 grit in a shellac bond. Clear water is used in this case as a coolant.

After nitriding, the material assumes the characteristics of hardened tool steel. It is quite readily susceptible to burning or checking and for this reason it is customary to use aluminum oxide wheels, usually vitrified bond, one or two grades softer than would be used on ordinary hardened steel. Listed in one of the tables are some of the general grain and grade recommendations for various types of grinding wheels for nitriding steels.

GRINDING WHEELS FOR NITRIDING STEELS

	Abrasive type	Grit size	Abrasive grade	Bond	Wheel speed, surface ft. per min.
Before nitriding:					
Cylindrical.....	Alum. ox....	36– 46	Soft.....	Vitrified..	5500–6500
High finish.....	Si-carbide...	46	Medium....	Vitrified..	5500–6500
Surface:					
Straight wheels....	Alum. ox....	46	Soft.....	Vitrified..	4500–5000
Cup wheels.....	Si-carbide...	36	Soft.....	Vitrified..	4500–5000
Centerless.....	Alum. ox....	46– 60	Medium....	Vitrified..	5500–6500
Internal.....	Si-carbide...	46	Soft.....	Vitrified..	5500–6500
After nitriding:					
Cylindrical:					
Rough.....	Alum. ox....	36– 60	Soft.....	Vitrified..	5500–6500
Finish.....	Alum. ox....	60–100	Soft.....	Vitrified..	5500–6500
Mirror finish.....	Si-carbide...	400–500	Soft.....	Shellac...	5500–6500
Surface:					
Straight wheels....	Alum. ox....	46– 60	Soft.....	Vitrified..	4500–5000
Straight wheels....	Alum. ox....	60	Very soft...	Silicate...	4500–5000
Cup wheels.....	Alum. ox....	46– 60	Soft.....	Vitrified..	4500–5000
Cup wheels.....	Alum. ox....	60	Very soft...	Silicate...	4500–5000
Internal.....	Alum. ox....	36– 60	Soft.....	Vitrified..	5500–6500
High finish.....	Si-carbide...	80–100	Soft.....	Vitrified..	5500–6500
Centerless.....	Alum. ox....	46– 60	Soft.....	Vitrified..	5500–6500

Hints for Lathe Operators—I

BY ALBERT HUFF

SET-UP OPERATIONS

1. Analyze all operations before starting work. Many jobs are difficult merely because they were started wrong.

2. Never take anything for granted. Before starting, inspect and oil the machine. Check set-up and tools.

3. To true up a piece, loosen the tool in the toolpost enough so that it can be turned against the work by hand, as in Fig. 1. Turn the chuck around once or twice by hand if possible. In this manner not only is the high spot found quickly, but exactly how much the piece runs out of true is shown. Next, move the jaws to bring the piece nearer center and push the tool until it touches the work again. Turn the chuck around once or twice, note the high spot again and reset the jaws. Repeat until the piece is running true.

4. Always set the toolholder so that if it moves it will swing away from the work, not into it, as in Fig. 2. This makes it possible to take heavy cuts without the tool digging in and ruining the piece. For heavy cutting set the compound at 45 deg.

5. To help true up pieces set in jaws a short distance, built in parallels and screw jacks as shown in Fig. 3 are very useful.

6. Always cut in the longest direction. If the piece is large in diameter and short in length, cut towards the center. If the piece is small in diameter and long, cut parallel to the length of the piece.

TURNING OPERATIONS

1. To eliminate chatter in old machines grind less clearance on the toolbits. Once a tool has been ground with correct angles for any particular lathe, a gage made of sheet metal will save many steps.

2. To center drill a piece accurately, spot a small V with a toolbit first, see Fig. 4, as few tailstocks are accurately in line with the lathe spindle. The spot in the work will help the drill find its correct position.

3. To turn a hard piece, grind a round nose on the tool, see Fig. 5, grind a negative back rake, use little side and end relief, and use a large feed. The round nose will help keep the edge sharp longer and will give more strength; the negative rake will pull the toolbit into the piece and help the cut.

4. Always set the toolbit well above center when turning. Under the pressure of the cut the tool will "drop" a little into the work, due to wear and play in the compound and cross slides and the saddle. When the feed is stopped at the end of the cut, the tool will rise to its natural position. When boring holes, the toolbit should be set below center.

5. Before making a cut, mark the length of cut with the toolbit. This will help eliminate mistakes, avoid unnecessary stopping of the machine to measure and give the operator a chance to relax.

6. Set calipers to approximate size of finish dimension; placing them on the end of the piece will quickly show the amount of stock to be removed.

7. When it becomes necessary to put a center in a long piece that is too large in diameter to go through the hole in the spindle, scribe cross lines on the end to be centered, using the center head of a combination square. Then chuck the other end and support the end to be centered with the steadyrest. Bring the tailstock center up close to the end of the work and note variation from cross lines. Adjust steadyrest jaws until the centers are fairly in line. True up the end held in the chuck by using a surface gage and indicator. Set the compound rest at 30 deg. and start the center with a toolbit as in Fig. 4, then use a center drill.

8. It is difficult to place a center in the spindle hole in the same position every time, making it impossible to do accurate work without first grinding the center. A piece of steel held in the chuck, as shown in Fig. 6, will save a lot of time. It takes but a moment to place it in the chuck and take a light cut over the center. The jaws of the chuck can serve as a stop for the dog.

9. To cut extra large diameter work

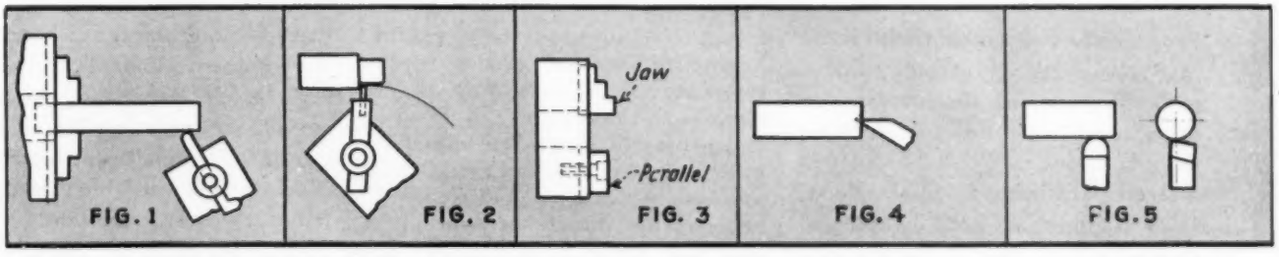


Fig. 1—With a reversed tool loosely held in the toolpost, the amount of eccentricity of chucked piece can be determined quickly. Fig. 2—Always set a lathe tool so that it will swing away from the work, not into it, should the toolpost screw become loose. Fig. 3—By spacing parallel blocks or screw jacks between chuck jaws, thin pieces can be located quickly. Fig. 4—By using a sharp-nosed tool, location of a center in the end of a chucked piece can be obtained accurately. Fig. 5—A round-nosed tool with negative rake is best for hard material

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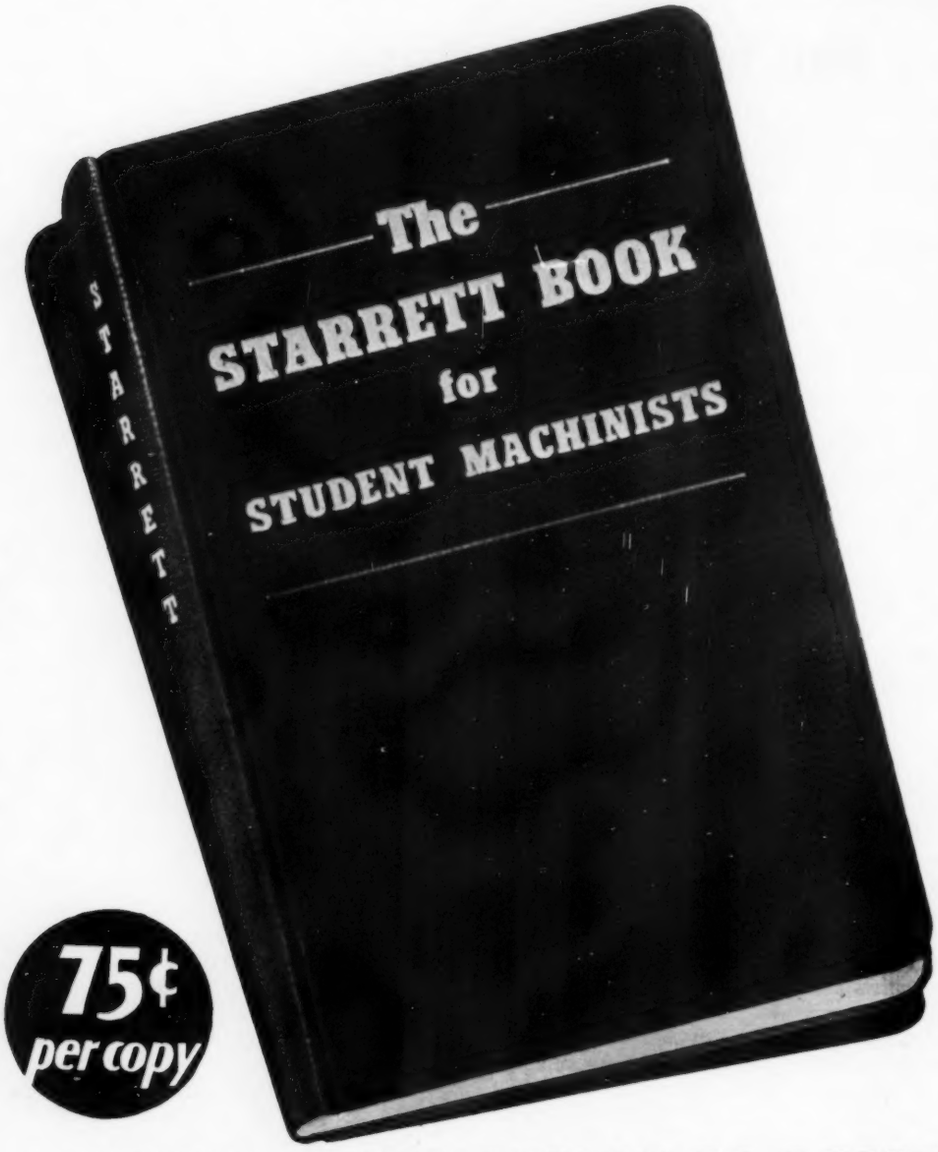

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Hints for Lathe Operators—II

that will not clear the saddle, use a boring bar to hold the turning tool, as shown in Fig. 7.

10. To cut off pieces rapidly in a lathe, move the saddle back and forth slightly to enlarge the groove as the cut is going deeper. This will prevent chips from packing and will permit a heavier feed. Also, round the end of the cut-off tool a little.

11. Always take a clean-up cut on a flange formed when reducing a diameter in order to true up axially as well as concentrically when the piece is turned, see Fig. 8.

THREADING OPERATIONS

Turning a "clean thread" is not difficult. First, be sure to remove the chip from the tool after every cut. If the depth of cut was heavy and the chip sticks on the top edge of the tool, stone off the chip before taking the next cut. This is very important when sizing the thread. Next, be careful of play in the leadscrew and nut. Under a heavy cut the play is taken out; a light cut will not do this. That is why a cut sometimes will suddenly dig in on one side of the thread, causing irregularities. To eliminate this danger, the following method has been found successful, even for old machines:

1. Set the compound rest at 60 deg. and grind a small radius on the edge of the tool. Set the tool as usual.

2. Rough out the thread by bringing the cross slide back to the same position after every cut, using the compound rest screw for depth adjustment. This way all the roughing cut is taken on the side of the thread that is nearest the headstock.

3. Start with a $\frac{1}{64}$ or $\frac{1}{32}$ in. depth of cut, depending on the pitch of the thread. As the depth of thread increases, lessen the depth of each cut, taking only a few thousandths near the finish. By observing the width of the flat on top of the thread, one will know when it is close to size.

4. When ready for the finishing cut, inspect the toolbit and if dull, regrind and reset. If not dull, stone the top of the toolbit to give a smooth cutting edge. To realign the tool with the thread, engage the leadscrew and run enough to take out end play, then stop the machine. By adjusting cross slide and compound rest screws, bring the right side of the toolbit (tailstock side) against the thread, disregarding the depth. If the original toolbit is used, back up the compound screw a few thousandths (be sure to take out end play). Then turn the cross slide screw until the right side of the tool touches the thread, and take a light cut. Keep turning the cross slide screw for each cut until the thread on the tailstock side is clean. Mark position of cross slide screw. Then turn the compound screw for each cut until depth of thread is reached.

5. Back up the cross slide (taking out end play) until depth of screw is a few thousandths less than before. By turning the compound rest screw, bring the tool forward to cut on the other side of the thread. Continue with light cuts until the thread is sized. Adjusting the screws make it possible to cut on one side or the other of the thread and prevent the tool from digging into the other side.

REAMING AND BORING

1. To eliminate bell-mouthed holes when reaming, chamfer the hole slightly. Hold the reamer in the tailstock chuck a short distance, keep turning the reamer until it is in the nearest correct position. Then tighten the chuck by hand, do not use a key (if reamer should get stuck in the hole it will slip in the chuck and not spoil the work). Lift the end of the reamer and guide it into the hole as the tailstock spindle is advanced.

2. To eliminate bell-mouthed holes when boring, grind as little radius as possible on the cutting edge of the toolbit. Set the cutting edge at right angles to the end of the hole, as in Fig. 9. As the cutting is on the side of the tool and not on the end, this reduces spring in the boring bar. This practice is very useful for rough castings and out-of-round holes.

3. When the lathe is not equipped with a carriage stop to make a shoulder in a hole to the correct depth, bring the toolbit forward until it just touches the edge of the work. Then clamp a piece of steel to the boring bar at a distance from the edge of the work equal to the depth desired. When the clamped piece touches the edge of the work, the correct depth has been reached.

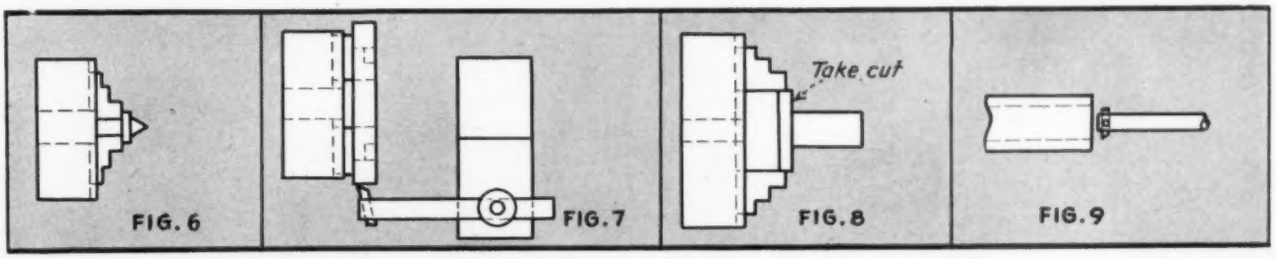
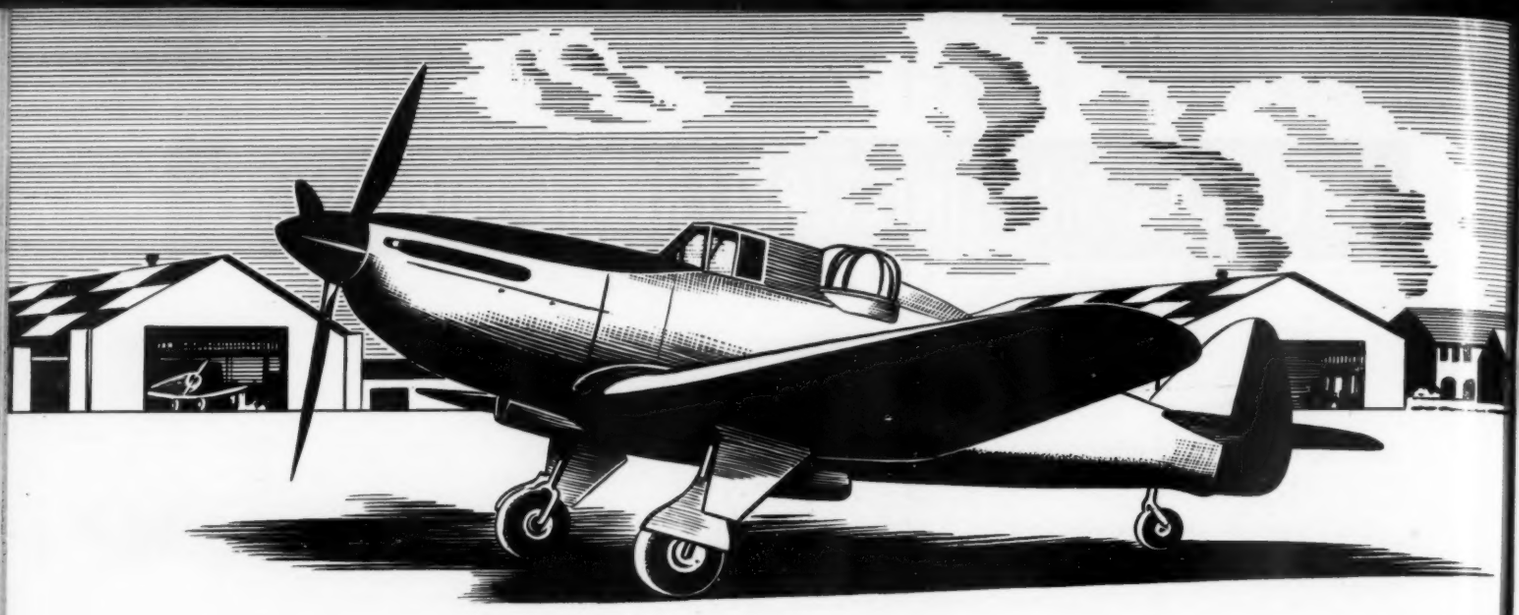


Fig. 6—A soft center held in the chuck jaws usually is more accurate than a standard center in the end of the lathe spindle. A light cut should be taken over such a center piece each time it is chucked. Fig. 7—To turn large pieces that will not clear the saddle, place the turning tool in a boring bar. Fig. 8—Always square up the flange left on a turned piece before removing it from the chuck. Fig. 9—Set the toolbit at right angle to the boring bar to eliminate bell-mouthed holes when boring



Planes also Break Records on the Ground

Production records. "Getting 'em into the blue" in ever increasing numbers is a job to which New Britain Automatics contribute speed, accuracy and dependability — the same important characteristics they bring to many another industry vital to National Defense. *New Britain-Gridley Machine Division, The New Britain Machine Company, New Britain, Conn.*

NEW BRITAIN AUTOMATICS

Stay on the Job

MODEL 60

A complete line of Multiple Spindle Screw Machines up to 2¼" Capacity
Also a complete line of Chuckers: Four, Six and Eight Spindles up to 10¼" Capacity

We Can Have Butter!

REMEMBER the talk about our producing all the guns and at the same time all the butter we might need?

Now that the defense program has raised its sights, we read a lot out of Washington about discarding butter entirely for guns. The Army and Navy will eat heartily at the materials table, whereas the poor, friendless civilian-goods industries must get along on the leavings.

If that radical course becomes necessary, all right. The American people still have plenty of what plain-spoken folks call guts. But before they give up things which have contributed notably to their standard of living, they rightly want proof that the tightening of their belts is essential.

Reading the daily papers, one might easily conclude that after defense activities get their fill of materials, even crumbs will be scarce. But is that impression correct? Is the situation as bad as it appears?

Some developments lead us to believe not. Apologists say that users would not be human if they didn't store an extra supply in the cellar when shortages threaten. The housewife does it with sugar. Instead of characterizing this trait as human, it might be termed hoarding.

Many industrialists strongly suspect the Army and Navy of being the worst hoarders of all. That is because no agency has been empowered to ascertain whether the requests of the armed services for steel, copper, aluminum and other materials are reasonable. No one has had the authority to find out whether the materials will be used immediately or six months hence.

Some curtailment in civilian goods manufacture is inevitable. It will grow as munitions production expands and eats up materials in larger quantities. But no company should be penalized, no employee forced into idleness, no merchant deprived of goods to sell unless such action is unavoidable.

All you must do to refute the gloomy story that no materials will be available for non-defense products is to sit down and figure for yourself. Steel is an example. Around 85,000,000 tons of ingots will be turned out this year. If the most liberal allowances are made, not over 35,000,000 tons will be required for direct and indirect defense purposes. That leaves 50,000,000 tons to fabricate into all sorts of steel products. That doesn't sound like a steel famine!

To make dead certain that the Army and Navy get what they need when they need it, and at the same time do not abuse the sweeping priorities favoring them, there should be a federal government agency with plenty of policing power. The duty of that agency should be to ration critical materials so that civilian goods can be made to the greatest possible extent without interfering with the defense program.

The President's executive order establishing the Supply Priorities and Allocation Board indicates that this new agency has the authority to do this all-important job. If that is true, as we hope it is, more power to the new board! It will be in the happy position of making sure that America's much vaunted industrial efficiency is used to the greatest advantage in a time of peril.

Burnham Finney

GAGING BUSINESS

Machine tool production goal of $750,000,000 in sight for 1941 as industry continues expansion. Russian defense plants will be tooled up with $10,000,000 in supplies from U. S. To help China

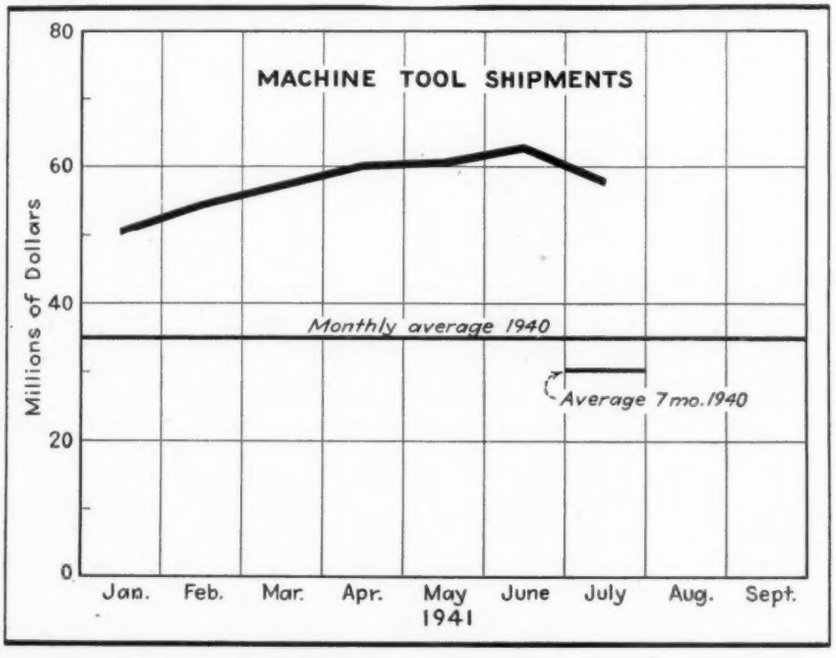
Approximately $10,000,000 of U. S. machine tools are to be sent to Soviet Russia to help that country build munitions to carry on the fight against Nazi Germany. At the same time Washington officials are formulating plans for furnishing China with machine tools to an amount as yet undetermined. Representatives of the Netherlands East Indies also are attempting to secure machine tools here so that their country can enlarge its capacity for turning out implements of war.

Machine Tools—The industry is continuing its expansion along many fronts by erecting new plants, taking on more men, training more workers, lengthening shift and improving productive efficiency. Output in August is believed to have been somewhat higher than in July. The goal of $750,000,000 of machine tools for the 1941 calendar year is almost certain of attainment. There is a good chance, in fact, that production will comfortably surpass that figure. The bomber program is well on its way. The method used to get the program started was to place so-called float orders up to 50 per cent of the machines which the Air Corps specified that contractors needed from machine-tool builders. In that way well over $100,000,000 of orders have been placed. No orders have yet come through for the enlarged tank-production program. The number of machine tools required for it will be under 3,000. The preferential rating list of defense projects to receive machine tools, issued early in July, is just going into effect. It has taken a matter of weeks for machine-tool builders to rearrange their scheduling so as not to upset their production volume. Some 20,000 used machine tools are still available for defense work. OPM officials say that the tooling of plants would be further speeded if companies around the country would release for sale hundreds of critical tools now standing idle.

Aircraft—August production is estimated to be well over 1,600 planes, a considerable increase over the volume during the preceding three months which had been bumping along at just under 1,500 a month. Output is now slightly behind the schedule. As recently as June, however, it was squarely on the nose of the schedule, which called for a steep climb from March to September. The lag lately has been because expansion of parts and plane equipment capacity fell behind that of primary plane producers. A factor which soon will tend to keep plane production below the 1941 schedule established a year ago will be the constant shift to heavier types of military craft. July's increase in four-engined bombers was achieved at the expense of manufacture of light bombers this fall. The effect on plane production arising from a shift toward bombers is indicated by the following estimate of July output: 600 trainers, 400 pursuit and other light types, 125 light bombers, 175 medium bombers and 50 heavy bombers. The bulk of the August gain was in pursuit planes. Plans are being worked out to switch over facilities originally intended for fighter planes to heavy and medium bombers. At present 150,000 men are employed in making airframes, 35,000 on motors and 8,000 on propellers.

Munitions—Britain and the United States will each concentrate on what it does best in arms production as a result of Lord Beaverbrook's visit. There will be more emphasis on tank and bomber manufacture. In setting up the program for building 1,000 medium tanks a month, beginning next July 1, defense officials may decide to erect a huge steel foundry where the entire hull will be cast and then sent to the various tank makers for assembly. So far as the new ordnance plants are concerned, a check-up shows that two of the powder plants, one TNT plant, seven shell loading plants, one toluol plant, one armor plate plant and one armor piercing core plant are now in operation. Three small arms ammunition plants will start production in September. Most of the new ordnance factories will not get going until the early spring of 1942. Production of 37-mm. anti-tank guns in August was 160 and will jump to 260 in September. About 340 81-mm. mortars were built in August. The schedule on 90-mm. anti-aircraft guns is 61 a month.

Steel—Mills are operating at or near full capacity and many of them did not pause for the Labor Day holiday. With full priorities in effect, the time is near when a considerable number of consumers may have to shut down operations in the production of civilian goods. Least affected by defense orders are hot and cold rolled sheet and strip, wire and tin plate. These items may be affected, however, by diversion of semi-finished steel to products such as plates, which are in extremely high demand for defense orders. If a liberal allowance is made of 35,000,000 tons of ingots for direct and indirect defense purposes, however, some 50,000,000 tons of steel ingots should be available on an annual basis for finished material for non-defense goods.



Shipments Nearly Doubled—*Although machine tool shipments in July were $5,000,000 less than in June, for the first seven months they were nearly double those of the similar period of 1940. Monthly average so far this year has been $57,800,000. At the present rate shipments will total $700,000,000 for the year*

Create Seven Man Priorities Board To Speed Production, End Defense Agency Conflicts

WASHINGTON—President Roosevelt, when he created a new seven-member supply priorities and allocations board last week, aimed at speeding up defense production and ending jurisdictional conflicts between defense agencies. The new board, headed by Vice-President Wallace, has sweeping powers to fix priorities and allocate the supply of materials, fuel, power, and commodities of all kinds to meet demands of Army, Navy, defense-aid program, and the civilian population.

Many key defense officials have been shifted to make up the new board. The personnel are: Vice-President Wallace; William S. Knudsen and Sidney Hillman co-directors of OPM; Secretary of War Henry L. Stimson, and Secretary of Navy Knox, representing respectively the Army and Navy consumer; Harry L. Hopkins, special assistant to F.D.R., will supervise the Lend-Lease defense-aid programs; Leon Henderson, Federal Price Administrator and Director of OPM Civilian Supply Division.

Nelson Named Executive Director

Other shifts were: Donald M. Nelson, named Executive Director of the Supply Priorities and Allocations Board, was also appointed Priorities Director of OPM. He had been OPM Purchasing Director. E. R. Stettinius, Jr., has been appointed Lend-Lease Administrator; he had been OPM Priorities Director. John D. Biggers was named Minister to London to meet the British request for a production man to speed Lend-Lease; Biggers had been OPM Production Director. Douglas MacKeachie was promoted to OPM Purchasing Director succeeding Nelson.

Although no announcement was made as to the successor to Biggers as OPM Production Director, it is likely that Knudsen will take personal command of the production effort, and that William L. Batt, now Assistant OPM Production Director, will move into a more important position in the same division.

While the White House announcement did not say explicitly that Stettinius was succeeding Hopkins as Lend-Lease Administrator, Stettinius will have active charge of the administration of the program while Hopkins will continue in a supervisory capacity in all defense aid.

The new defense set-up was worked out by Justice Samuel I. Rosenman of New York at FDR's request. The move was said to be a voluntary agreement between OPM, OPACS, and the Secretaries of War and Navy.

Henderson's Office of Price Administration and Civilian Supply has been changed to the Office of Price Administration. The supply branch has been shifted to OPM as a separate division also headed by Henderson. The branch will continue to work out programs for civilian allocation to be submitted to the new board for approval.

While the new board has broad powers, its policies will be formed by the President. For example, the question of distribution of finished material such as planes, guns, or ships, will remain with FDR. The one important function of the board will be to determine the requirements of materials and commodities needed respectively for defense and civilian purposes, and to establish policies for the fulfillment of such requirements, and to make recommendations to the President where necessary. No agency had this power heretofore and it was contended by many to be responsible for the failure to expand production of materials and the subsequent existence of shortages.

Nelson as Executive Director of SPAB and Priorities Director of OPM, will be the active administrating officer of the new board, and under its broad policy and regulations will pas on more than 20,000 priority applications weekly.

Douglas Gets Large Order

WASHINGTON—The Douglas Aircraft Company, Santa Monica, Calif., was awarded last week a $176,316,000 War Department contract for airplanes and parts. Other large awards were: for aircraft, to Bell Aircraft Corp., Buffalo, $75,218,384; to Wright Aeronautical Corp., Paterson, N. J.; and to North American Aviation, Dallas, Texas, $6,-980,612; and for automatic screw machines to New Britain Machine Co., New Britain, Conn., $4,467,315.

Defense Order Must Come Ahead of Civilian Demand

WASHINGTON—Defense orders and sub-orders are now compulsory and are to take full priority over civilian demands. Under Priorities Regulation No. 1 issued late last month any person who is offered a defense order for his usual product at his usual prices must accept it unless this will mean deferring existing higher rated orders. An exception is made if the proffered order calls for delivery within 15 days.

Regulation No. 1 is a new fundamental document of the priorities system. What it does is take the definitions and detailed requirements which have been incorporated in most of the priority orders on specific materials, recodify them, and make them applicable to all commodities, equipment, or products, whether or not a specific priority order governing the distribution of that commodity has been issued.

The compulsory order feature is not absolutely novel. It has been incorporated in two or three of the most recent general materials orders. But now for the first time it applies to all defense contracts. A defense order is defined in the regulation as one placed by the Army, Navy, Maritime Commission, Panama Canal, Coast and Geodetic Survey, Coast Guard, Civil Aeronautics Authority, National Advisory Committee for Aeronautics and the Office of Scientific Research and Development; by the governments of the British Empire, Belgium, China, Greece, the Netherlands, Norway, Poland, Russia and Yugoslavia; orders placed under the Lend-Lease Act; and orders having a priority rating of A-10 or higher.

Tanks Coming Up—*Tanks worth $1,000,000,000 will be produced for the U. S. Army next year. To expedite this program, OPM has loaned its tank unit to the Ordnance Department. M-3 28-ton medium tanks (above) are coming off the three assembly lines at Chrysler Corp.'s Tank Arsenal at Detroit*

566 SHIPS, 20 WAYS ADDED TO MARITIME PLANS

Commissions' program would produce 1400 vessels by end of 1943 with 2 launchings per day at peak. Expect orders for more ways

WASHINGTON—Plans for the construction of 566 additional cargo ships to carry war supplies for the Democracies passed the preliminary phase last week as the Maritime Commission completed negotiations for the building of 66 of these newly authorized ships and for the construction of 20 extra ways in existing shipyards. The new vessels and additional ways will cost $1,698,650,000, which was provided in the $7,500,000,000 Supplementary Appropriation Bill.

Progress on this new program, which brings the total number of vessels on the Maritime Commission's construction list to 1,400, will keep expanded yards busy through 1943 and at the height of the construction program will provide two new ships per day. However, as all available building facilities will be occupied, at least through 1942 on existing contracts, many other ways will be ordered in the near future.

The 66 new cargo carriers for which negotiations have been concluded will be of the standard commission "C" type, costing between $2,200,000 and $3,000,000 each. These ships will be built by: the Consolidated Steel Corp., which will construct 26 ships; the Gulf Shipbuilding Corp., Mobile, Ala., will build 16; and the Ingalls Shipbuilding Corp. and the Bethlehem Co. will construct 10 and 14 respectively.

Each Way Costs $1,000,000

New ways ordered last week at an estimated cost of $1,000,000 each were as follows: South Portland Shipbuilding Co., South Portland, Me., two; Bethlehem Steel Co., Sparrows Point, Md., two; Alabama Shipbuilding and Drydock Co., Mobile, eight; Ingalls Shipbuilding Co., Pascagoula, Miss., two; Delta Shipbuilding Co., New Orleans, La., two; Consolidated Steel Corp. Ltd., Los Angeles, four; and Richmond Shipbuilding Corp., Richmond, Calif., three.

"Two ships a day will keep the Nazis away," is the new slogan of the Maritime Commission as enunciated by Admiral Land. However, it is more than a slogan as it will be accomplished by 1942, while by the end of 1943 the Maritime Commission will have built 1,400 ships.

It all began five years ago when the U. S. created the Maritime Commission to make an immediate survey of the needs and requirements of the merchant marine. The result was that a program of construction contemplating the building of 500 ships in ten years—a ship a week—was adopted. The purpose of this program was solely to replace worn and obsolete ships sailing under the American flag. Although the first contract wasn't awarded until the Fall of 1937, the Commission's long-range program soon became well organized and, with the war in Europe in the early Fall of 1939, was accelerated.

By February, 1941, an emergency program had been conceived, superimposed on the original Maritime Commission's program, and when put into operation would produce 200 special designed vessels known as "Liberty Ships" within a two-year period. These emergency ships will be placed in service in from 4½ to 6 months from the time the keel is laid. This tempo reduces by 50 percent the construction time during the World War which was between 10 and 12 months per ship.

Under the terms of the Lend-Lease Law, the President asked that the program be expanded to include 222 more ships, 112 of these to be the Liberty type and 110 Maritime Commission's standard designs of cargo vessels and tankers. This called for further expansion of existing yards but within 30 days provisions had been made for those expansions and the additional ships were under order.

Then came the supplementary appropriation bill, a further program of construction calling for 566 additional ships, as well as of 48 additional ways and existing shipyards. That bill has just become law.

The shipbuilding program which started out in 1937 to be an orderly production of 500 ships in ten years has mushroomed into an enormous project with a total of 1,383—nearly 1,400—vessels of all types, the great bulk of them to be completed and delivered by the end of 1943. From one ship a week in the original program, the U. S. now plans on delivery into service of approximately two ships a day throughout 1942 and 1943.

Meanwhile facilities for production of steam turbines and gears for merchant ships have been expanded. Recently the Maritime Commission called for the investment of $50,000,000 to expand four plants; financing will be done under lease agreement by the Defense Plant Corp. with RFC funds. They are: Westinghouse Electric & Manufacturing Co., Lester, Pa., $22,000,000; General Electric Co., Erie Pa. and West Lynn, Mass., $24,500,000; Allis-Chalmers Manufacturing Co., West Allis, Wis., $2,250,000; and DeLaval Steam Turbine Co., Trenton, N. J., $1,250,000.

Machinery Exports Decline To Lowest Level Since 1939

WASHINGTON—Dropping to the lowest value since the closing months of 1939, U. S. exports of industrial machinery in June amounted to $28,337,146, a decline of 22 percent from the May total of $36,508,569, it was reported by the Department of Commerce.

Exports of Machinery During June, 1941

	June 1941	May 1941	June 1940
Electrical machinery and apparatus	$8,733,635	$12,276,019	$9,607,069
Power-generating machinery, except electric and automotive	2,586,486	4,295,292	2,126,581
Construction and conveying machinery	2,615,313	3,358,836	3,115,301
Mining, well and pumping machinery	2,429,269	3,249,537	3,788,489
Power-driven metal-working machinery	12,103,426	15,611,065	18,564,300
Other metal-working machinery	1,448,794	1,531,070	596,917

Metal-Working Machinery

Engine lathes	527,812	529,129	1,530,297
Turret lathes	1,063,191	1,064,629	1,451,624
Other lathes	673,668	820,541	888,025
Vertical boring mills and chucking machines	440,257	581,371	809,499
Thread-cutting and automatic screw machines	1,462,095	1,794,372	1,120,424
Knee and column type milling machines	768,474	1,218,886	367,955
Other milling machines	1,338,533	1,731,463	1,438,827
Gear-cutting machines	367,202	539,756	798,420
Vertical drilling machines	87,559	247,143	261,353
Radial drilling machines	36,048	109,925	200,808
Other drilling machines	220,484	319,368	714,837
Planers and shapers	146,864	478,694	338,424
Surface grinding machines	257,571	599,475	298,060
External cylindrical grinding machines	384,598	359,908	437,110
Internal grinding machines	114,725	150,928	562,989
Tool grinding, cutter grinding and universal grinding machines	464,994	482,383	306,839
Other metal grinding machines and parts	213,328	468,545	748,398
Sheet and plate metal-working machines and parts	621,226	1,065,306	714,319
Forging machinery and parts	696,247	825,570	763,117
Rolling-mill machinery and parts	441,544	227,136	2,884,832
Molding machines	13,435	21,991	23,690
Other foundry equipment parts	218,925	252,299	176,041
Other power-driven metal-working machinery and parts	1,507,920	1,710,228	1,723,787
Pneumatic portable tools	122,434	146,860	73,285
Other portable and hand or foot-operated metal-working machines and parts	167,879	201,967	174,436
Chucks for machine tools	67,946	83,601	56,508
Milling cutters, machine-operated threading dies and taps, and similar machine-operated metal cutting tools	562,349	681,072	106,649
Other metal-working machine tools and parts	528,186	417,570	186,039

Hawk's Nest—*By next year, U. S. aircraft production will reach 3,000 planes per month and top that of any other nation, according to OPM Director General Knudsen. Last month Curtiss-Wright Corp. dedicated a new factory (above) to produce fighter craft at the Buffalo Municipal airport. From this plant Hawk P-40 pursuits and Kittyhawk fighters will swarm to defend the world's democracies. Over 200 partly completed planes are moving along the assembly line. Floor space of this $18,000,000 plant totals 1,500,000 square feet. Workers (above left) are operating a battery of Fosdick drill presses*

Pressure Brings Increased Subcontracting Despite Opposition by Army, Many in OPM

WASHINGTON — Subcontracting is again the watchword in Washington, and this time there is real steam behind it. For months it has been one of those things, like standardization or economy, that everyone speaks highly of but no one does anything about. Proponents of subcontracting have been able to make a good theoretical case that it was an essential way to big quick production. But in practice, it's a nuisance to all concerned, and until subcontractors learn their jobs it may seriously delay final production. Army and most of the Office of Production Management, therefore, have been pretty cool, and all the scurrying of enthusiasts in OPM has produced little more than $26,000,000 in sub-contracts.

But, today, small industries all over the country are really feeling the pinch of priorities. Hundreds of them are shutting down or laying off men. It is estimated that at least a million men will have lost jobs by December as a result of material shortages. The obvious solution for these crippled businesses is to get some defense work, so they have been bombarding Congress and other agencies with pleas for help.

As a result of this new demand, OPM, Army and Navy last month agreed on major changes in purchasing procedure. Three particularly important are:

1. Bidders on Army and Navy contracts of more than $50,000 will be required to state in their bids the amount of the work which they propose to subcontract.

2. Priorities on new machinery will not be given to defense contractors unless they satisfy the contracting officer that there are no qualified subcontractors within a reasonable distance who could do the work.

3. The Defense Contract Service is made a major Bureau of OPM, reporting directly to Knudsen and Hillman. DCS was set up some months ago in an OPM corner to disseminate propaganda and advice on subcontracting.

One particular responsibility will be to route contracts or subcontracts to communities and industries which are hard hit by restrictions on civilian production. Whenever cases are brought to DCS, either directly or through the labor division of OPM, it will analyze the facilities available, figure out what sort of work could be done, and make recommendations to the secretaries of War or Navy. The Secretaries, it has been agreed, will then transmit to their departments "such specific directives as they determine necessary in the interests of national defense to carry out the procedure recommended."

Several procedures which DCS might recommend are acceptable to Army and Navy. It may ask that negotiated contracts or subcontracts be awarded to specific companies or groups of companies; prices on such contracts might run as much as 15 percent above current quotations; and in the case of subcontracts the prime contractor would be reimbursed for the extra cost. It may ask that bid and performance bonds ordinarily required be waived and that prompt payment be assured by inspecting products at the plant, thus reducing capital requirements.

CIO Delays Aircraft Pact To Get Stronger Position

WASHINGTON—By refusing to discuss labor conditions on an industry wide basis, CIO has stymied Sidney Hillman's first attempts to put through an aircraft labor stabilization agreement. Move appears to be more of a delaying action, to give CIO leaders an opportunity to strengthen their position. At present they control only one major producer—North American, and some smaller plants like Brewster, Vultee and Ryan.

But, vigorous organizational campaigns are underway at Douglas, Consolidated and Curtiss-Wright. If CIO gets these three in its pocket, it could walk into a stabilization conference as the dominant union of the industry. Also, contributing to its opposition is fear that workers would look to the agreement for protection rather than the union, and sheer antipathy to Hillman.

It would be a mistake, however, to write off the prospects of a pact. For, Hillman attaches great importance to his agreements, has the consent of employers, is in a position to get large concessions for employees, will put his full authority behind the task. This is a combination hard to buck.

In a survey of all industry, the Bureau of Labor Statistics found that five times more man-days were lost because of strikes during the first seven months of this year than in the corresponding period of 1940. The loss of 15,750,000 man-days through July, furthermore, was 44 percent above the average during the same periods from 1935–39. A total of 1,327,000 workers were involved in 2,505 strikes.

Canada Duplicating U. S. Material Controls To Assure Imports; Post-War Plans Drafted

MONTREAL—To assure imports from the U. S., Canada has inaugurated a new policy of duplicating U. S. controls over strategic materials. First commodity to come under such control is steel. Every pound of steel produced, imported and used will be documented hereafter, so that it can be shown that all steel is put to essential use. This system was adopted to avoid criticism from some U. S. sources that supplies have been used for unnecessary purposes. For Canada must import considerable steel from that country which is already on short steel rations. Actually, Canadian controls, though less complicated, have been more effective and far reaching than those applied in the States. Among other instances, pig iron has been under mandatory control for months, and automobile production has been reduced to less than half of last year's output. Canadian motor plants, however, are far advanced in conversion to war work.

Consider Post War Plans

Canada has begun to consider post-war conversion of war industries to provide for peace-time civilian needs. At the next session of Parliament a special committee will recommend the appointment of a single corporation, board of trustees or similar public body, whose responsibility will be to safeguard and conserve the hundreds of millions of dollars of government investments in plants during the war, and to plan the shift of production from war to peace-time work after the war. Empowered to study war administration, the committee will also recommend salvage of materials; avoidance of wasting food, equipment, ordnance stores and gasoline; eliminating unnecessary duplication of hospital facilities; and placing of more power in the hands of civilian authorities to curtail extravagance in various military departments.

Although main reliance for aluminum scrap is from industrial salvage, the pots and pans drive will play two-day stands in the three main regions of the country. The drive was staggered over three weeks so as to facilitate marketing arrangements and movements of the aluminum scrap to aircraft plants. A new reclamation plant is being established by the Aluminum Company of Canada in Toronto. At its plants alone, General Motors of Canada estimates nearly 22,000,000 lb. of scrap metal containing a substantial amount of aluminum is salvaged annually.

More rigid control of civilian consumption of materials needed for war purposes was indicated by the switch of the Wartime Prices and Trade Board to the Finance Department from the Labor Department. Powers of the prices board, which through the finance department will work closely with the Bank of Canada, are being extended to cover all types of consumer goods—necessaries as well as luxuries. It will aid the Wartime Industries Control Board in giving precedence to war industries for strategic materials. A further aim of the new set-up is to end the friction between the agriculture department and the prices board.

In line with the government's intention to undertake a greater share of the Empire Air Training Program, the Mackenzie Air Service, Ltd. of Edmonton, is launching a $1,000,000 expansion plan to increase its facilities for repairing and assembling planes used at air training centers. Coinciding with this announcement was the completion of the first Avro-Anson training plane at the Amherst, N. S., plant of the Canadian Car & Foundry Company. Output will be stepped up from one per week. The first Canadian-made anti-aircraft gun, also, was completed during the week by the Otis Fensom Elevator Company, Hamilton, Ont.

Shipbuilding Expanded

Most of the 1,600 parts for this fast-firing Bofors gun were made in Ontario plants.

Extent to which Canada has shifted industrial facilities to war work is well illustrated by the Canadian Car & Foundry Co. Nine of its ten plants are at work producing Hurricane fighter aircraft, Harvard and Avron-Anson training planes, Hampden bombers, shell, hydraulic propellers with aluminum or wooden blades, and propeller heads. While these plants are operating at full capacity, the remaining plant is working part-time on railway equipment.

Shipbuilding facilities have been expanded and organized to such an extent that 1,000,000 tons of new ships should be launched in 1942. Recently announced contracts for this industry included $23,684,000 placed with Marine Industries, Ltd. of Montreal; $17,253,000 placed with Burrard Drydock, Ltd. of Vancouver and $8,035,200 placed with Victoria Machinery Depot, Ltd. of Victoria.

Other contracts recently let included $746,701 to the Ford Motor Co. of Canada, Ltd., Windsor, Ont. for land transports; $856,041 to MacDonald Bros. Aircraft Corp., Winnipeg, $472,840 to Fairchild Aircraft, Ltd., Longueuil, Quebec, and $130,054 to Noorduyn Aviation, Ltd., Montreal for aircraft; $1,203,012 to Ford Motor Co. of Canada, Ltd., Windsor, Ont., and $197,100 to Atlas Steels, Ltd., Welland, Ont. for ordnance; and $265,663 to Creighton & Smith, Fredericton, N. S., and $105,570 to Oshawa Engineering & Welding Co., Oshawa, Ont. for munitions.

DEFENSE SIDELIGHTS

WASHINGTON — Price Administrator Henderson established a 52-cent ceiling on grade A pig tin after last month's rise from 53 to 55 cents . . . OPM ordered pig iron producers to set aside 2 per cent of September production in urgent defense pool. Pool will get an estimated 90,000 to 100,000 tons . . . Defense Plant Corporation will build and lease to Republic Steel facilities for producing 1,572,000 tons of pig iron per year. Vanadium has been put under priority control; production this year is about 3,750,000 lbs. while demand is 5,900,000 and will be 7,150,000 next year.

Slack in Auto Employment To Exist Until Late 1942

DETROIT — The automotive industry will not experience a boom in employment from its munitions and airplane manufacturing activities until near the end of 1942. In fact, total employment during the defense emergency may never equal the figure in a top automotive year. Certainly defense production will not have gone far enough by midsummer 1942, to take up the slack in employment as the result of curtailment of motor car output.

Today only a small percentage of automotive workers is engaged in defense work. At the Rouge plant, where 135,000 men are employed, it will number only a few thousand at most. In the entire industry, which the first half of this year had 526,000 people on its payroll, over 40,000 are currently employed in defense work.

Nevertheless, the industry should do well in total volume of all kinds of business—passenger cars, trucks, buses, military vehicles, airplanes, munitions—during the current model year. The schedule calls for 2,160,000 passenger cars and 1,190,000 other vehicles of all types. That means that the total projected production would be 3,350,000 units. It is believed that the December quota of automobiles to be built will be 205,000 units, compared with 235,000 a month in September, October and November.

At present Detroit has some 135,000 automotive employees out of work. Washington authorities are trying to bring motor car companies and prime defense contractors together to provide additional work in this district. If the success of the program the past two weeks for subcontracting parts for Continental Motors is any criterion, new defense work should come into Detroit in good volume. Ford, among others, is seeking defense contracts to keep the Rouge plant busy.

One of the bad spots is the big body plants where large presses stamp out body parts. These plants are not adapted to much defense work.

INSIDE DETROIT

OPM curtails auto production 26½ percent to save materials, avoids consequences of wholesale layoffs that larger cut would bring. A-3 preference rating for trucks needed by Army and industry

BY RUPERT LE GRAND, DETROIT EDITOR

DETROIT—Curtailment No. 2 clipped 75,000 passenger cars from the original long-range estimate of permissable output in the August-November period. Trucks are unaffected so far. Instead of the 30 percent slash expected by insiders or the 40-50 percent curtailment feared by many in the industry, OPM decided that a reduction of 26½ percent from the similar four-month period of 1940 will save enough materials and perhaps avoid the political-economic consequences of wholesale layoffs that would follow an immediate 50 percent cut. During the last model year 4,297,000 cars were produced.

At the same time a substantial increase will be made in the output of motor trucks due to increased transportation and military needs. A blanket preference rating of A-3, the same rating granted previously for freight cars, is being prepared by OPM to aid truck manufacturers in obtaining scarce materials quickly. Priorities assistance applies to trucks of one and one-half tons or more.

Figure Production Schedules

Motor car companies immediately began to refigure production schedules, employment, stocks of materials and the many other details involved in this major change. The exact degree of curtailment was unknown; there are signs that OPM's new energy in releasing defense contracts and forcing subcontracting will soon show results. Consequently, further acceleration in transfer of auto workers to defense tasks may be expected. The picture has changed so drastically in the past two weeks that certain interests will not merely project from earlier studies of unemployment transfers of workers to defense but will undertake new analyses of their own situations. It will be at least two weeks before factual data can be set up. The 32-hr. week clause in union contracts will probably prevent excessive idleness in some automotive cities.

On September 15 the government will announce the passenger-car reduction necessary for December, and on the fifteenth of every month thereafter it will fix the quota for each additional month. Washington now unhesitantly speaks of the "expectancy of a 50 percent curtailment for the model year ending July 31, 1942." Which is by way of saying that the outlook for passenger-car production will get progressively worse from December on.

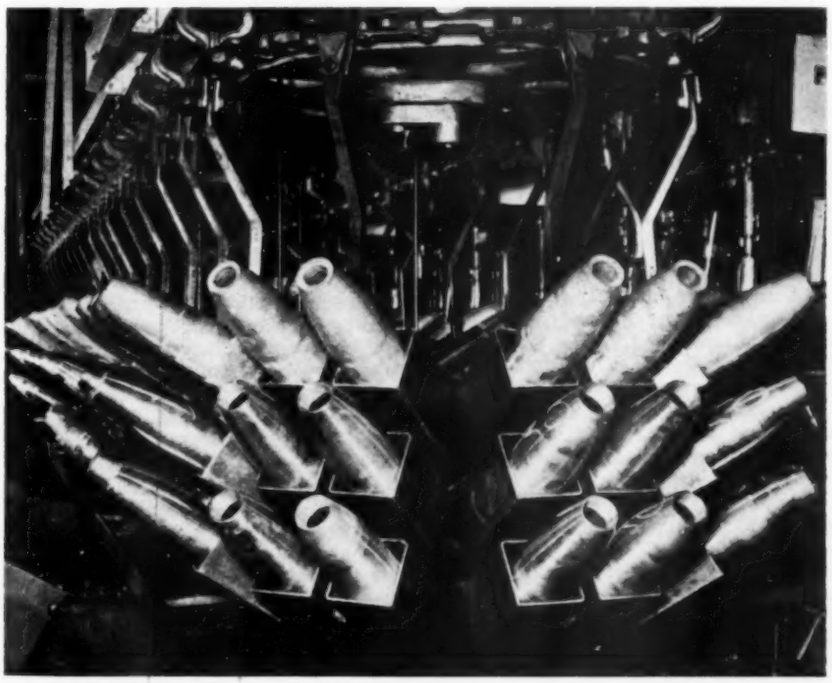
The new curtailment is forced solely by a lack of raw materials. Other consumer-goods industries are to be placed on curtailed production quotas not only to save materials but to "correct" forward buying. When these ends have been achieved the materials left over from rising defense production will be allotted among the several industries. Local sources believe that refrigerator manufacturers will get their quotas for the new season early in September. The auto industry will not get preferential treatment for left-over materials.

Trucks are presently exempt from curtailment. In another long-range forecast, it is said that 1,189,000 trucks will be required in the current model year, or 200,000 more than output in the year ended July 31. This estimate (which is viewed locally as a shot in the dark) includes trucks for the Army, Navy, Lend-Lease, export to Russia and highway hauling. Emphasis is to be laid particularly upon building trucks from two tons and up, although the curtailment order says that a priority rating of A-3 (the same as freight cars) has been given to vehicles of 1½ tons or more. Local manufacturers understand that commercial cars can be produced in the same volume as in 1941 and that there are no limits on trucks above one ton, ability to get materials being the only determining factor. But from reliable sources it is understood that curtailment of commercial cars and trucks under 1½ tons is in the offing, that a ceiling of 25,000 units per month will be allocated among the several producers according to their portion of the 1941 model-year total. Normally commercial cars and light trucks make up 44 percent of total truck production.

Continuance of truck manufacture at 100,000 units per month, or even more, will not offset the loss in passenger car output. While it is true that total

NASH AIDS PRATT & WHITNEY

DETROIT — Nash - Kelvinator is planning to make approximately fifteen major components of the Pratt & Whitney engine upon a sub-contracting basis. Space in the Reo plant, where Nash is now setting up to produce propellers in volume, will be used it is said. Engine components to be manufactured are cylinders, crankshafts, connecting rods and other intricate machined parts.



Faster Shelling—*General Motors has already delivered $7,000,000 of shells, guns and fuses for defense. To further speed shell making, the forge plant of the Oldsmobile Division at Lansing, Mich., has been redesigned. The conveyor carries 105-mm. shell. This plant also makes 75-mm. shell*

operations of U. S. plants may not be down more than ten percent during the four-month quota period as compared with the similar interval in 1940, the best measure of the decline is to compare the new rate with output in April-July 1941. The figures for U. S. production in that period were 1,546,000 passenger cars and 390,000 trucks. The new quota figure on "pleasure cars" is 817,000, and truck production will probably better 400,000 units. At the worst then, the total curtailment will be in the order of 720,000 units for the four months, or a drop in operations of 37 percent.

The three major companies, and General Motors in particular, are hit hardest by the new curtailment order. The formula for curtailment was based on the average production over the past three years, a period during which G. M. garnered a larger percentage of the total market and shoved four cars into the first six in registrations. A marked portion of this increase has taken place in the last year. The major producers were supposed to take a 40 percent whack, the independents a 15 percent cut based on the three-year average. Some confusion seems to exist on just how much G. M. expects to suffer as compared with 1941, but the figure of a 54.5 percent reduction in passenger-car production has been tossed out. Ford said that its passenger-car production for the four-month quota period will be off 45 percent as compared to the four months ending July 31, 1941, and that when its passenger car and unrestricted truck production are counted together, the slash in total automotive manufacturing will amount to 35 percent. Studebaker and Hudson were the two independents to give up most under the method of figuring quotas because those concerns usually get an early start on new models and have an appreciable August production. Nash, which had an unusually low output last fall because of production difficulties, actually won a small increase.

New Hudson Is Lower, Longer

Hudson has completed showings of 1942 models in which the basic engineering is little changed; but body styling is lower and longer, and a new front-end treatment is used. The Drive-Master, an optional extra, consists of two vacuum cylinders which with governor and controls shifts gears automatically, semi-automatically or manually as the driver chooses.

Packard has extended its Clipper styling to a light six and basic models of the 160 and 180 eights on a 127-in. chassis. Certain conventional models and formal cars are continued. Clipper styling is said to improve gasoline economy from 12-18 percent even at low speeds. Aluminum pistons will be continued in Packard engines for initial production, but tooling is ready for light-weight cast-iron pistons when the change is necessary.

Dealers are now showing the new Plymouth with 95-hp. engine. The body has been outflared as in all 1942 Chrysler products to conceal running-boards. Light-weight cast iron pistons are used in a slower speed engine, which has a compression ratio of 6.80 to 1, and is said to have improved economy.

Chrysler Corp. showed its new cars to 200 newspaper men on Aug. 26, as the last attraction in its all-day tour of defense activities. Visitors saw the tank plant in full production, viewed Army truck manufacture, looked at tooling up for Bofors guns and Martin bomber fuselage sections. Chrysler disclosed that experimental work on its 2,000-hp. aircraft engine and a hitherto undisclosed project—a 500 hp. liquid cooled tank motor—is well advanced.

General Motors will follow Chrysler's preview method by showing all new lines at the G. M. Proving Grounds on Sept. 10, in connection with a display of defense activities. Throughout the General Motors line, the influence of Cadillac styling will be pronounced. Front fenders will flare into front doors, and rear fenders will now be continued into the rear doors. Bodies will be a couple of inches lower and will be wider.

Scrap Is "Gold"—*Important as civilian pots-and-pans drives are, the greatest source of scrap metals is industrial salvage. For 20 cents, General Electric salvages a dollar's worth of material. H. J. Beattie and A. J. Lacock, who head G.E.'s salvage and manufacturing methods departments, look over a pile*

OPM Sets Up Committee To Aid in Re-employment

WASHINGTON—In order to head off in every possible way the unemployment resulting from the curtailment of passenger car production, an emergency National Committee on Automobile Employment was set up last week within the Labor Division of the Office of Production Management. The Committee, composed of representatives from the U.S. Employment Service and the Labor Relations, Priorities, Defense Training and Training Within Industry branches of the Labor Division, will cooperate with labor and industry committees on re-employment and retraining of workers for defense jobs.

The objects of the program as outlined by OPM Associate Director General Hillman are: (1) orderly transfer of workers to defense plants now being built by the automobile industry; this includes a training program to prepare workers for defense jobs. (2) orderly transfer of workers to other defense industries. (3) fitting of additional defense work into equipment now devoted to passenger car output.

The three point program, combined with the heavy demand for trucks, is expected to minimize the effect of the passenger car curtailment on the industry and its employees. Similar curtailment of other durable goods industries will be carried out as quickly as possible in order to distribute equitably the materials remaining after defense needs are met.

Information on pending labor displacements, obtained through Employment Service channels, will be sent to the Priorities branch of the Labor Division, and forwarded to the Defense Contract Service to guide it in its subcontracting activities. Under this procedure the Priorities branch will certify to the Defense Contract Service that labor is threatened with loss of jobs, because of material shortages in certain non-defense plants, industries or communities. The Defense Contract Service will propose negotiation of contracts, waiving the usual bidding procedure, or other methods of awarding defense jobs for the plants affected.

TO REPLENISH THE SCRAP PILE

WASHINGTON—From backyards, barns, tool sheds, cellars and attics; from abandoned spurs and short lines of railroads; from unused street car lines; from automobile "graveyards"; and from all other likely corners of the U. S. OPM and industry will scrape up all old iron and steel to replenish the scrap pile. From January to July, steel mills and foundries consumed 31,000,000 tons of scrap iron and steel, more than in any full year or World War I. As a result scrap supply in many sections is dangerously low.

WATCHING WASHINGTON

Confusion in defense administration hides production results. Starting in 1942 at least 1 merchant ship, 20 tanks, 100 planes, 12 pieces of artillery will be completed per day. To fix faults

By ROBERT COLBORN

WASHINGTON — With the serious phase of the defense effort just about a year old, Washington is full of soul-searching and recrimination. Widespread is the feeling that defense has bogged down, enmeshed in hopeless confusion. Senator Byrd and the President toss production statistics at each other, and all Washington is overjoyed at a story—not true—that Judge Rosenman has been commissioned to wipe out the defense agencies and start fresh.

Most of the criticism is justified. But it, and its reflections in the newspapers, can give a misleading impression. Weakest thing in the program is the organization at the top, and it is this rather than the shops and foundries that Washington sees. In terms of physical production the program has certainly not bogged down, is probably going ahead about as fast as anyone could have hoped—short of a miracle.

Production Figures Are Secret

As long as production figures are secret, no one outside the government can say definitely how it stands. But the picture seems to be that we are now just entering the period of mass production. The plants laid down last fall are either producing or will be within a few weeks. The latter part of this year will see substantial quantities of armament turned out, and 1942 will be a year of real production —greater than Germany's in some major categories. From the start of the year, every day will see better than one merchant ship, 20 tanks, 100 planes, perhaps a dozen pieces of artillery, come into service.

To put it differently, with the country not yet in the war, arms production has already reached the stage which was only achieved at the end of the World War. The year after the last war was the period of big production, and 1942 will be equivalent to 1919. A year ago, the big question was whether American industry could get rolling before Hitler mopped up Europe. Short of an unexpected upset, the answer now seems to be in the affirmative.

But encouraging as production may be, the paradox of results in the shop and creaking administration upstairs cannot continue indefinitely. Explanation of the paradox, of course, is that until the last few months it didn't really matter how the program was run. Armament production was simply taking up the slack in the economy, and except for a few isolated bottlenecks all Washington had to do was shovel out the money and the contracts; industry could do the rest. If Superman himself had been running the job, there probably wouldn't be many more tanks or ships on hand now than there are.

That was the situation for the first six months. But by March shortages were beginning to show up here and there; priorities began to be the order of the day. And by June every major metal was under priority control, was being produced to capacity and still not meeting the need. Industry as a whole is running at or near capacity, and future progress in arms output is going to require some high-powered thinking.

No longer can the technical skill of the individual industrialist get out the goods. He needs help from Washington. Decisions have to be made between conflicting objectives; the supply of steel, men, machines has to be kept in balance; frictions and inefficiencies have to be eliminated. In brief, the economy has to be planned. And present attempts to do the job are terribly weak.

The major faults in the present set up are pretty generally recognized. One, for which the President must bear the chief blame, is the unbelievable clumsy organization of the defense agencies. Armament production is being run by a dozen loosely-knit bodies with overlapping jurisdictions and insufficient powers. OPM is supposed to see that the economic potential of the country is utilized, and has no authority over the placement of contracts. OPACS is supposed to control the price level without any authority at all. Another agency is supposed to see that defense workers are housed without any authority over where they are put. Decision on the necessity of new plants and on whether financing shall be provided is in different and sometimes conflicting hands. Almost nowhere except in the White House is there clear authority to make final decisions.

Weakness Also at OPM's Door

A second and perhaps more serious weakness lies at the door of OPM itself. It is lack of vision—lack of grasp on the dimensions of the job in hand. Only rarely has Washington realized the implication in a policy of making this country the "arsenal of democracy"—that arms production can only be limited by physical capacity. OPM almost always has waited for the Army to set a program for them, to give them a production schedule, has felt helpless in the absence of a program. It has not realized that the job is to revamp a whole economy, and that it's not a job for soldiers.

Admittedly, OPM has had insufficient authority, but it has used this lack as an alibi rather than demanding more. Perhaps the essence of the situation is that men of the stature required by the job have not yet come forward. There are a lot of men from industry in OPM, says one official, but few who *are* industry. The current plea for a Czar of defense is obviously too simple; it would merely substitute a bottleneck in the Social Security Building for the bottleneck at the White House.

But dimly the outlines of a practical organization are perhaps beginning to emerge. The recent reorganization of OPM into commodity sections, each dealing with an industry, seems to point a general direction. It suffers though from the fatal weakness that the sections are too far from the source of authority. The highest ranking officials who spends all his time thinking about iron or about tanks or machine guns is still three or four steps below the level at which major decisions can be made.

Use Plastics to Save Metals

WASHINGTON — As strategic metal supplies grow tighter, the U. S. Army Ordnance Department and Quartermaster Corps are pushing expansion of the use of plastics in military equipment. This development has gone far beyond the popularly known uses of knife handles, combs, mess kits, brushes, buttons, inkwells, liners for steel helmets, and truck and telephone parts. Experiments are being conducted with plastics for windshields for 37 mm. armor piercing shells, bodies and bomb fuses and fins for mortar shells.

Naturally, rigid specifications have been imposed for today's high speed warfare demands exacting performance. For example, plastic caps on certain armor piercing shells must be accelerated in their 4-ft. trip to a gun barrel with a velocity of 0 to 2,800 ft. per sec., and must at the same time acquire a standard more than 10,000 r.p.m.

U. S. Government Contracts Awarded to Metal-Working Firms

(Does not include contracts under $100,000)

Source	Agency	Commodity	Amount
Fleetwings, Inc., Bristol, Pa.	War	Airplanes and spare parts	$4,555,614
Fargo Motor Corp., Detroit, Mich.	"	Trucks, ambulances	1,143,850
Curtiss-Wright Corp., Buffalo, N. Y.	"	Wing panel units	772,800
Dowty Equipment Corp., Long Island, N. Y.	"	Assemblies	759,200
The Denison Engineering Co., Columbus, Ohio	"	Hydraulic test stand assemblies	616,737
Kinner Motors, Inc., Glendale, Calif.	"	Engines and parts	745,342
Curtiss-Wright Corporation, Robertson, Mo.	"	Airplanes and spare parts	28,150,924
North American Aviation, Inc., Dallas, Texas	"	Airplane maintenance parts	1,340,788
Cummins Diesel Engine Corp., New York, N. Y.	"	Generating sets	237,451
Greenville Steel Car Co., Greenville, Pa.	"	Car, fire control	199,230
" Quick-Way " Truck Shovel Co., Denver, Colo.	"	Cranes, attachments and trailers	383,076
C. R. Jahn Co., Chicago, Ill.	"	Trailers	135,500
Scullin Steel Co., St. Louis, Mo.	"	Bomb bodies	1,499,270
American Brass Co., Metal Hose Div., Waterbury, Conn.	"	Mast base; mast section.	300,995
The National Cash Register Co., Dayton.	"	Fuze bodies, discs	244,500
Kingston Products Corp., Kokomo, Ind.	"	Fuze, metal parts	646,000
General Motors Corp., Delco Brake Div., Dayton, Ohio.	"	Mine fuze	644,380
Bailey Products Corp., Union City, Ind.	"	Mine fuze	314,500
American Car & Foundry Co., New York, N. Y.	"	Shell	10,902,450
W. C. Norris Mfr., Inc., Tulsa, Okla.	"	Metal parts; shell	574,024
General Steel Castings Corp., Eddystone, Pa.	"	Castings	375,091
Pittsburgh Steel Foundry Corp., Glassport, Pa.	"	Castings	540,390
National Forge & Ordnance Co., Irvine, Pa.	"	Tube forgings	131,840
Struthers-Wells-Titusville Corp., Titusville, Pa., American Locomotive Co., Schenectady, N. Y.	"	Tube forgings	148,992
Western Pipe & Steel Co. of Calif., Los Angeles, Calif.	Treasury	Buoys	103,150
Parish Pressed Steel Co., Reading, Pa.	War	Reel	104,800
Gilbert & Barker Mfg. Co., West Springfield, Mass.	"	Water chests	523,792
Superior Metal Products Co., St. Paul, Minn.	"	Anti-tank mines	164,224
Garden City Plating & Mfg. Co., Chicago, Ill.	"	Fuze	139,998
Shanklin Mfg. Co., Springfield, Ill.	"	Fuze	160,020
The Tredegar Co., Richmond, Va.	"	Projectiles	159,932
Reynolds Metals Co., Louisville, Ky.	"	Aluminum foils, rods	253,637
The Four Wheel Drive Auto Co., Clintonville, Wis.	"	Tractors	190,275
American Monorail System, Cleveland, Ohio.	"	Monorail system	170,561
Cincinnati Milling Mach. & Cincinnati Grinders, Inc., Cincinnati, Ohio.	"	Centerless grinders	298,250
Savage Arms Corp., Utica, N. Y.	"	Guns	14,334,470
International Harvester Co., Chicago, Ill.	"	Tractors	2,155,553
Bendix Products Div., Bendix Aviation Corp., South Bend, Ind.	"	Hydraulic charger assys.	281,892
Caterpillar Tractor Co., Washington, D. C.	"	Tractors	187,018
Wallace & Tiernan Co., Inc., Belleville, N. J.	"	Water purification unit	190,201
Wallace & Tiernan Co., Inc., Belleville, N. J.	"	Water purification unit	104,550
Caterpillar Tractor Co., Washington, D. C.	"	Motor graders	106,218
The Whitcomb Locomotive Co., Rochelle, Ill.	"	Locomotive	127,660
The Buffalo-Springfield Roller Co., Springfield, Ohio	"	Road rollers	216,524
Pratt & Whitney Div., Niles-Bement-Pond Co., West Hartford, Conn.	"	Drill press	148,890
Hannifin Mfg. Co., Chicago, Ill.	"	Recoil mechs	2,006,000
Austin-Hastings Co., Inc., Cambridge, Mass.	"	Lathes	159,000
Fairchild Engine and Airplane Corp., Hagerstown, Md.	"	Airplanes and parts	4,746,951
American Safety Razor Co., Brooklyn, N. Y.	"	Housings for shell	400,925
Automatic Machine Products Co., Attleboro, Mass.	"	Primers	108,000
The Hoover Co., North Canton, Ohio.	"	Fuze	126,000
International Machine Tool Corp., Indianapolis, Ind.	"	Lathes	397,332
Seneca Falls Machine Co., Seneca Falls, N. Y.	"	Lathes	468,000
American Steel & Wire Co. of New Jersey, Donora, Pa.	"	Bars	225,164
Peco Mfg. Co., Philadelphia, Pa.	"	Fuze caps and bodies	262,500
Peco Mfg. Co., Philadelphia, Pa.	"	Fuze bodies and caps	415,000
Cincinnati Ball Crank Co., Cincinnati, Ohio.	"	Burster casings	284,050
American Locomotive Co., Schenectady, N. Y.	"	Forgings	392,040
Struthers-Wells-Titusville Corp., Titusville, Pa.	"	Steel tube for forgings	148,992
Seneca Falls Machine Co., Seneca Falls, N. Y.	"	Lathes	109,000
American Brake Shoe & Foundry Co., American Forge Div., Chicago, Ill.	"	Shell forgings	507,960
Gabriel Co., The, Cleveland, Ohio.	"	Shell bodies	610,000
Dresser Mfg. Co., Bradford, Pa.	"	Shell forgings	962,500
Oliver Farm Equipment Co., Springfield, Ohio.	"	Metal packing	804,100
Kilby Steel Co., Anniston, Ala.	"	Shell forgings	6,127,200
Electric Household Utilities Co., Chicago, Ill.	"	Booster parts	755,590
Murray Mfg. Corp., Brooklyn, N. Y.	"	Shell bodies	1,792,000
Regina Corp., Rahway, N. J.	"	Fuze, bomb nose	548,895
Armstrong Cork Co., Lancaster, Pa.	"	Cartridge cases	520,000
John Dunlap Co., Carnegie, Pa.	"	Cartridge cases	970,000
Pullman Standard Car Mfg. Co., Butler, Pa.	"	Shell	915,000
W. C. Norris Manufacturer, Inc., Tulsa, Okla.	"	Shell	574,024
National Supply Co., Spang-Chalfant Div., Ambridge, Pa.	"	Shell forgings	5,093,130
Pittsburgh Steel Co., Allenport, Pa.	"	Shell	1,890,000
Weatherhead Co., Cleveland, Ohio.	"	Fuze	599,500
Gisholt Machine Co., Madison, Wis.	"	Lathes	668,500
American Brass Co., Kenosha, Wis.	"	Brass cups	16,047,668
Mackintosh-Hemphill Co., Pittsburgh, Pa.	"	Castings	356,927
Federal Cartridge Corp., Minneapolis, Minn.	"	Cartridges	127,800
LeBlond Machine Tool Co., Cincinnati, Ohio.	"	Lathes	172,989
Carboloy Co., Inc., Detroit, Mich.	"	Furnaces, tools	137,747
Struthers-Wells-Titusville Corp., Titusville, Pa.	"	Forgings	464,835
J. E. Beaird Corp., Shreveport, La.	"	Shell	378,000
Weatherhead Co., Cleveland, Ohio.	"	Fuze	130,800
Aluminum Seal Co., New Kensington, Pa.	"	Cups for percussion primer	224,700
Cessna Aircraft Co., Wichita, Kans.	"	Airplanes and spare parts	12,043,867
A. S. Campbell Co., Inc., Boston, Mass.	"	Cartridge cases	1,864,000

COORDINATE TANK PRODUCTION

WASHINGTON — Full authority over all tank production in North America is being centralized in a newly organized tank unit in the Ordnance Branch of the War Department. The former division of authority which saw the Army draw specifications, OPM secure producers, while Army again let contracts, has been wiped out by moving OPM's tank unit into the Ordnance Branch. Lt. Col. John K. Christmas will have charge of all U. S. tank production and for that at Montreal Locomotive Works.

Chrysler is building medium tanks at about 125 monthly; American Car & Foundry, light tanks at better than 200 a month. By the end of the year production will reach 500 a month, half light, half medium. New plans call for doubling this by July, 1942. In a major change present producers will concentrate more on final assembly and pursue an extensive program of subcontracting parts and subassemblies. Major improvement in tanks are power-operated turrets, and a gyro-stabilizer, a device which probably holds a gun steady while the tank lurches around in motion.

Army Defines "Machine Tool" As Used in Bomber Contracts

Confusion as to the interpretation of the term "machine tool" as it refers to 4-engine bomber contracts issued by the Materiel Division of the Air Corps was eliminated by a ruling addressed to the Boeing Aircraft Co. According to the contracting officer of the division, the term "machine tool" when assigned a preference rating of A-1-A applies not only to machine tools but to fixtures, attachments, machining jigs, measuring devices, punches, hydraulic presses, dies, forging hammers, furnaces and all instruments and attachments necessary for the operation of these machines. The A-1-B rating covers airframes, their materials, parts and components, and to materials and facilities for the construction of assembly jigs and templets used in the assembly of airframes.

273 JULY TRUCK ORDERS

CHICAGO—July orders of industrial trucks totalled 273 units worth $1,059,093, according to the Industrial Truck Statistical Association. In the previous month 287 units with a value of $948,005 were ordered. Cantilever type trucks of capacities ranging from 1,000 to 20,000 lb. form the bulk of July bookings with 205 units worth $791,855. Cranes of 500 to 6,000 lb. capacity at 6 ft. radii followed, being ordered to the number of 41.

President, V-P, Niagara Machine Tool *Joins Copperweld* *Promoted by Crown*

F. E. MUNSCHAUER

G. R. KINNEY

D. G. BAXTER

R. P. SWARTZ

KnudsenRecommendsBoosting Alumina Production Capacity

WASHINGTON—A further increase of 600,000,000 lb. in the country's annual production of alumina, the material from which aluminum is derived, has been recommended to the War Department by the Office of Production Management. William S. Knudsen, OPM Director-General, recommended that a plant with capacity to produce 500,000,000 lb. of alumina annually be built in Arkansas, and that another plant previously recommended for construction in the same State should have a capacity of 500,000,000 lb. instead of the 400,000,000 first proposed. OPM also recommended that extraction of alumina from alumnite be started on a small scale at Marysdale, Utah.

New Process May Alleviate Predicted Brass Shortage

CLEVELAND—If adopted, the new process by which American Fork & Hoe Co. makes shell casings from alloy steel will greatly alleviate the predicted shortage of brass. Canadian and U. S. ordnance departments have ordered steel casings for test purposes. Steel, furthermore would be less expensive.

In Washington, meanwhile, Office of Production Management officials estimated the brass requirements for a 3,000,000 man army will be 202,000,000 pounds per month. Production is now far short of that figure and including all expansion planned will reach only 188,000,000 pounds by early 1943.

OPM's estimate of requirements excludes Navy, British and civilian needs. Something has to happen soon. Contrary to claims of brass companies, OPM and the Army think some increased production could be had in five months if temporary equipment is installed.

NAMES in the NEWS

Frederick E. Munschauer, vice-president and treasurer, has been elected president, Niagara Machine & Tool Works, Buffalo, N. Y. He has been employed by the company for 33 years. George R. Kinney has been elected vice-president. Associated with the company for 22 years, he had been sales manager.

D. G. Baxter has been appointed general superintendent of the Copperweld Steel Co.'s Warren, Ohio, plant. He has been associated with the American Steel & Wire Co., Pittsburgh Crucible Steel Co., Republic Steel Corp., and the National Tube Co.

F. B. Kilbourn, president and director of Canadian Refractories Ltd., has been appointed Canada's steel controller and chairman of the Wartime Industries Control Board. He succeeded H. D. Scully, who will continue to serve as Commissioner of Customs. Mr. Kilbourn is also vice-president and director of the Canada Cement Co., Ltd.

Victor A. Hanson has been promoted to general sales manager, The Whitney Chain and Manufacturing Co., Hartford, Conn. He had been assistant sales manager and field manager.

H. G. Smith has been appointed executive engineer in charge of the automotive and industrial engineering division and of the radial diesel division, Buda Co., Harvey, Ill. He had been chief engineer, automotive division, for several years.

George Brouwer, former vice-president, National Piston Ring Co., has been made general superintendent and production manager, Ramsey Manufacturing Co., Fruitport, Mich.

Richard P. Swartz has been promoted from vice-president to assistant to the president, Crown Can Co., Philadelphia, Pa. Previous to becoming vice-president in charge of production at all can manufacturing plants, he had supervised manufacturing methods at the company's Philadelphia plant and had been manager of its machine shops in Baltimore.

W. M. Barenger has been appointed assistant district engineer of the General Electric Co.'s central district. Since 1928 he had been a member of the Application Engineering Section of the company's central district.

Charles F. Hammond has resigned as superintendent, Cartridge Division, Winchester Repeating Arms Co., to become assistant to the president, the A. F. Holden Co., New Haven, Conn. He was for 22 years chief metallurgist of the Winchester Co.

Thomas B. McCabe, president of the Scott Paper Co., Chester, Pa., has been appointed deputy director in charge of operations of the Division of Priorities of the Office of Production Management. Mr. McCabe, who served last year with the Industrial Materials Division of the National Defense Advisory Commission, succeeds James L. O'Neill.

Anders Petterson has been appointed chief engineer of the Giern & Anholtt Tool Co., Detroit, Mich. He had been assistant to the experimental engineer of the Bower Roller Bearing Co., and before that was resident engineer of the IMO Industries, Stockholm, Sweden.

Paul E. Whitney, previously associated with General Electric Co. as advertising manager of the Home Bureau Division, has become business manager of the Frontier Machine & Tool Co., Troy, N. Y.

PLANT EXPANSION

William B. Given, Jr., of New York, who has been chairman of the board, has been elected president of the National Bearing Metals Co., St. Louis, Mo. He succeeds John B. Strauch who was elected chairman of the board.

Allis-Chalmers Mfg. Co., Milwaukee, Wis., under a lease agreement with the Defense Plant Corp., will build and equip a plant at Greenfield, Wis., at a cost of $9,066,964. Of this amount $4,961,526 will go for machinery to be used in the production of bomber equipment.

Basalt Rock Co., Inc., Napa, Calif., under a lease agreement with the Defense Plant Corp., will purchase $150,000 worth of equipment to be used for the building of ships.

Cone Automatic Machine Co., Windsor, Vt. has received an authorization from the Defense Plant Corp. to increase by $125,000 its present commitment of $350,000 for additional machinery and equipment. The facilities will be used in the production of machine tool equipment.

Consolidated Steel Corp., Los Angeles, Calif., has been granted approval of the Harbor Commission to lease approximately 94 acres of port land on which to build a $1,000,000 shipbuilding plant.

Goodyear Aircraft Corp. is erecting a $500,000 airplane parts factory at Litchfield Park, near Phoenix, Ariz.

Hollup Corp., a subsidiary of National Cylinder Gas Co., is building a new plant containing 100,000 sq.ft. of floor space on a 4-acre site in Cicero, Ill. The Torchweld Equipment Co., another subsidiary, will also be located in the new plant.

Jack & Heintz, Inc., Cleveland, Ohio, has received an increase of $146,089 under its lease agreement with the Defense Plant Corp. for additional machinery. The original authorization was $1,293,121.

Lockheed Aircraft Corp. is erecting an 80 x 100-ft. machine shop and assembly building, and a 27 x 134-ft. assembly and storage building. Total cost will be $50,000.

The National Acme Co., Cleveland, Ohio, through a lease agreement with the Defense Plant Corp., is acquiring $488,000 worth of machinery and equipment. This expansion was certified by the War Department as being necessary for national defense.

Odenback Shipbuilding Corp. will construct and equip a shipbuilding plant at Manitou Beach, N. Y., at a cost of $870,000, under a lease agreement with the Defense Plant Corp. Of this amount $150,000 is designated for machinery.

Phelps-Dodge Copper Products Corp. will build a new plant at a cost of $725,000 at Wilmington, Calif.

A. O. Smith Corp., Milwaukee, Wis., is purchasing $2,760,132 worth of machinery and equipment for the manufacture of airplane parts. This expansion has been authorized by the Defense Plant Corp.

Zollner Machine Works, Fort Wayne, Ind., are instituting a $249,000 expansion program to step up production of systems for the automobile industry.

BUSINESS ITEMS

Baker Industrial Truck Division of the Baker-Raulang Co., Cleveland, Ohio, has appointed George H. Criss as district representative for the Pittsburgh territory.

S. F. Bowser & Co., Inc., Fort Wayne, Ind., has acquired the outstanding stock and will operate the Fostoria Screw Co., Fostoria, Ohio.

Hamilton Standard Propeller Division of the United Aircraft Corp., East Hartford, Conn., has named Samuel P. Crago as Dayton representative. He will coordinate schedules and act as liaison officer on experimental work being conducted for U. S. Army Air Corps.

Hobart Brothers Co., Troy, N. Y., has appointed John L. Foley as their distributor in the Buffalo territory.

Induction Heating Corp. has moved to 389 Lafayette St., New York, N. Y., from 791 Broadway.

Lyon Iron Works, Greene, N. Y., has changed its name to Lyon-Raymond Corp.

OBITUARIES

Philip B. J. Bloedel, owner of the Bloedel Manufacturing Co., Buffalo, N. Y., died suddenly August 19.

Roger D. Howell, 64, assistant plant superintendent of Bliss & Laughlin, Inc., died of a heart attack on August 16 at Harvey, Ill. He had been with the company for 20 years and was a brother of Walter R. Howell, the president.

Stephen W. Dimick, vice-president of the Colt's Patent Fire Arms Manufacturing Co., Hartford, Conn., died August 5 in West Hartford. In 1923, after an association with the Winchester Repeating Arms Co., he joined the Colt's Co. as manager of western sales with headquarters in Chicago. Later he took charge of the small arms division and was elected vice-president in 1939.

Guy K. Keely, 63, treasurer Keely Die & Tool Co., died recently of a heart attack in Goshen, Ind. e was former executive excise commissioner of Indiana and a former member of the local city council.

Frederick E. Poor, 59, experimental engineer with the Pitney-Bowes Postage Meter Co., died August 5 in Stamford, Conn. He had been with the company since its organization 20 years ago and installed the first postage meter in 1921 at Utica, N. Y.

Charles T. Ransden, 71, vice president of the Beloit Iron Works, Beloit, Wis., died Aug. 3.

William H. Wilber, 65, who organized and for 35 years managed the Southern Skein & Foundry Co., Chattanooga, Tenn., died of a heart attack August 10 in Trion, Ga. Before founding the Chattanooga Co. he had worked for 11 years with the Illinois Iron & Bolt Co.

MEETINGS

Associated Machine and Tool Dealers of America. Fall meeting, Hot Springs, Va., September 12–13.

American Mining Congress. Eighth Annual Metal Mining Convention and Exposition, San Francisco, Calif., September 29-October 2.

American Society for Metals. Twenty-third National Metal Congress and Exposition. Convention Hall and Commercial Museum, Philadelphia, Pa., Oct. 20-24.

American Society of Mechanical Engineers. Fall meeting. Louisville, Ky., Oct. 12-15.

American Society of Tool Engineers. Semi-annual meeting. Royal York Hotel, Toronto, Canada, Oct. 16-18.

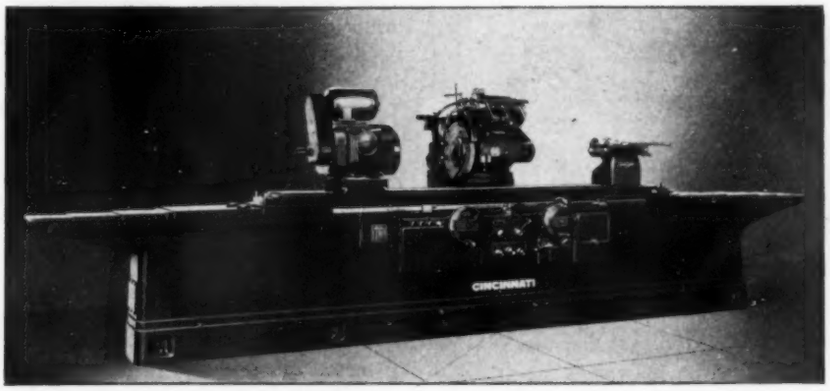
American Welding Society. Annual meeting and convention. Bellevue Stratford Hotel, Philadelphia, Pa., Oct. 19-24.

Society of Automotive Engineers. National Tractor meeting. Schroeder Hotel, Milwaukee, Wis., Sept. 25-26.

Society of Automotive Engineers. National Aircraft Production meeting. Biltmore Hotel, Los Angeles, Calif., Oct. 30-Nov. 1.

SHOP EQUIPMENT NEWS

Cincinnati Hydraulic Universal Grinder Line Increased with 14-, 16- and 18-in. Machines



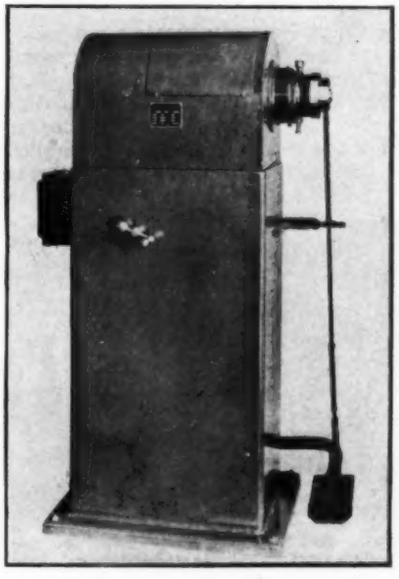
Embodying features similar to the 12-in. hydraulic universal grinder introduced last year (*AM*—Vol. 84, page 105), a series with 14, 16 and 18 in. swings and 36, 48 and 72 in. between-center lengths has been announced by Cincinnati Grinders Inc., Cincinnati, Ohio. The hydraulically powered table has infinitely variable traverse rates from 3 to 220 in. Power table stroke can be set as short as $\frac{1}{32}$ in., producing an effect comparable to the action of a reciprocating grinding wheel spindle. Automatic reversal accuracy of 0.004 in. allows operators to power grind close to shoulders without fear of spoiling work.

Hand table traverse has two mechanically controlled speeds: $\frac{1}{10}$ in. per turn of the handwheel for fine adjusting and shoulder grinding, and $\frac{15}{16}$ in. for setting up. Like the hand table traverse, the hand cross traverse has a two speed adjustment: 0.050 in. per turn of the handwheel in low gear and 0.250 in. in high gear. The automatic pick feed can be set to reduce the work diameter from 0.0004 to 0.014 in. per pass.

Mounted on top of the wheelhead unit is the 5 hp. motor that drives the grinding wheel spindle. The internal grinding unit contained in a hinge type bracket also is attached to the wheelhead. When not in use, it is completely out of the way, but can be swung quickly into operating position and tightened by one bolt. The head stock unit is driven by a ¾ hp. motor at speeds from 25 to 225 r.p.m., or from 40 to 360 r.p.m. in an optional range. Speed changes can be made instantaneously. All controls are closely grouped for convenience. To further reduce fatigue, work rotation and coolant flow start and stop automatically with the table traverse. Coolant also can be controlled independently. Built-in leveling jacks ease the periodic task of releveling. Net weights vary from 7,600 lbs. for the 14 x 36 in. model to 10,000 lbs. for the 18 x 72 in. model.

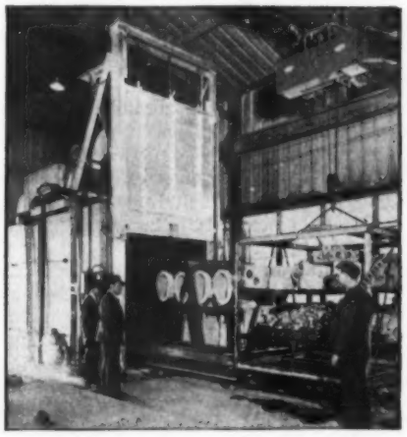
Foot Treadle Operates Motor And Brake On Schauer Lathe

Equipped with a treadle for opening motor circuit and applying an automatic brake to the spindle, the new Model VAIE variable speed lathe, brought out by Schauer Machine Co., 2063 Reading Road, Cincinnati, Ohio, can be used for accurate lapping and polishing of small parts. Speeds range from 20 to 4,000 r.p.m., thus permitting heavy as well as light work. Belt tension is automatically controlled by the spring mounting of the motor in lathe base. Spindle is equipped with 3- or 4-jaw chuck, or special work holding fixtures.



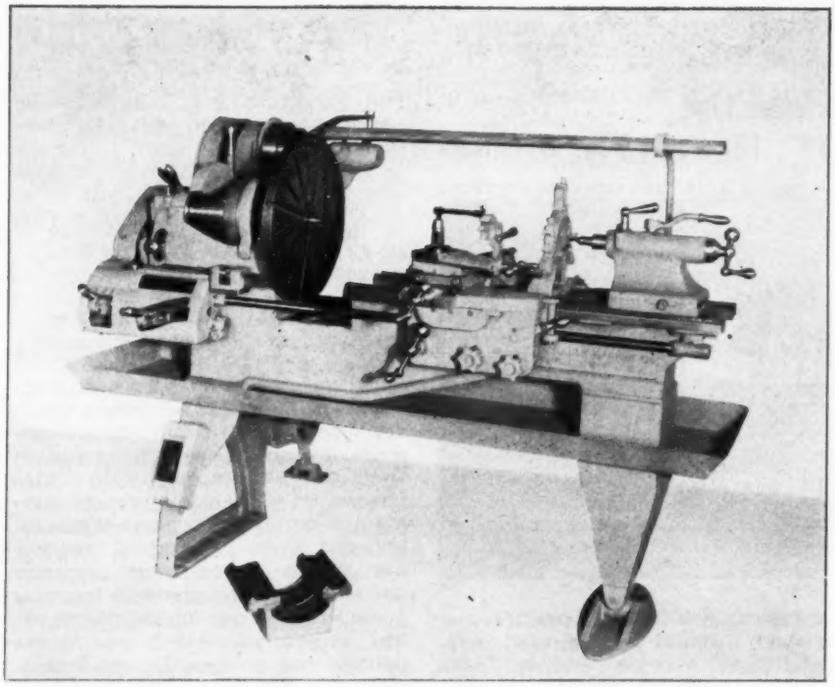
Despatch Panel Type Furnace Can Be Rapidly Installed

Rapid installation and dependable accurate performance is claimed for a new type of heat-treating furnace construction announced by Despatch Oven Co., Minneapolis, Minn. This furnace is recommended for tempering and drawing alloy steel, normalizing and stress-relieving of castings and welded sections, and numerous other heat-treating processes requiring a temperature range up to 1,200 deg. F. The furnace illustrated is used for the solution and precipitation heat treatment of aluminum and magnesium alloy castings and parts at National Bronze and Aluminum Foundry Co. This furnace has a capacity of 10,000 lb. of aluminum castings per charge.



The furnace has the Despatch indirect gas fired heating system (radiant tube construction type) amounted on the top. A 17,000 cu.ft. per min. fan forces air around the radiant tubes and into each distributing duct inside. No combustion gases enter the furnace working chamber. This furnace can be quickly fabricated at the factory, in special panel sections. Complete erection of the furnace requires only 8 days. Because of its special construction, the furnace can be easily moved if required, or it can be quickly enlarged for greater production if this is demanded.

Redesign 14-in. Lathe for Mobile Service To Repair U. S. Army Equipment in Field



For repairing U. S. Army rifles, guns, tanks and trucks in the field, the Seneca Falls Machine Co., Seneca Falls, N. Y., has redesigned its Star 14-in. engine lathe with removable gap block for mobile service. Special legs and motor drive unit permit mounting in Army or other service trucks. This light weight lathe (1,700 lbs., not including motor or equipment) can handle work with large diameter flanges.

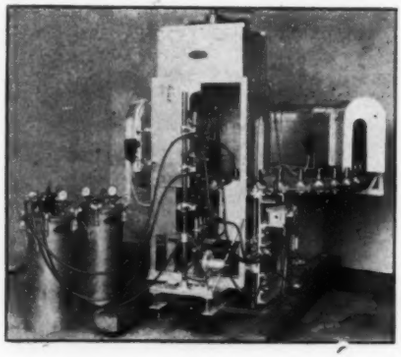
The universal joint at the foot of the tailstock leg absorbs the twisting and weaving of the truck platform. Thus, it prevents distortion of the lathe bed and misalignment of the lathe. The motor is mounted on a bracket attached to the head leg. A swinging member, which can be set in two positions, is supported by the bracket and carries the auxiliary cone. When it is in the back position, the drive belt is taut between the cones. In the forward position the belt is loose, permitting the spindle and face plate to be revolved by hand.

Finished inside and outside, the cones are balanced for high speeds. The tailstock is of the offset pattern with long bearing on bed. The spindle has a self-discharging center and a side adjustment for taper turning. Carriage and compound rest cross feed screws have micrometer collars graduated in thousandths of an inch. A phosphur bronze worm, receiving power from the head spindle through spur gears, actuates power cross and longitudinal feeds.

The taper turning attachment, secured to back of the carriage, is available for the full length of the bed. A wide range of standard threads also can be cut. Transposing gears and index for metric threads, likewise, are supplied. General specifications of this lathe are: swing over bed, 14⅛ in.; swing over gap, 21 in.; distance from spindle nose to end of gap, 7¼ in.; swing over carriage, 8⅛ in.; hole through head of spindle, 1⅛ in.; and distance between centers, 36 in. Eight spindle speeds are provided.

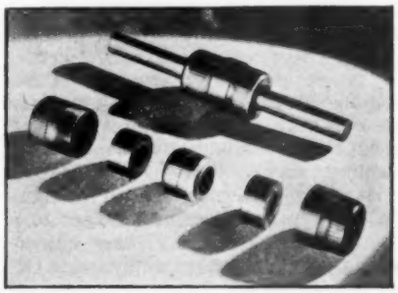
Eclipse Shell Spraying Machine Features Photoelectric Control

Action of the spray gun in a new automatic shell spraying machine manufactured by Eclipse Air Brush Co., Inc., 400 Park Ave., Newark, N. J., is controlled by an electric eye device so that there is no spray unless a shell is in the work holder. In the operation of the machine, which coats the insides and outsides of projectiles in one operation, the shell are placed on the indexing turntable manually, are carried around to a position in front of the automatic spray gun that coats the outside, while an extension nozzle on another gun comes up to spray the inside. After being sprayed, the shell enter a steam jacketed oven that is built over the back of the table. When they emerge from the oven, the projectiles are removed by the operator. This machine will handle 75-mm. armor piercing shell at a rate of 500 per hour.



Torflex Drive Shaft Couplings Require No Pins, Keys, Screws

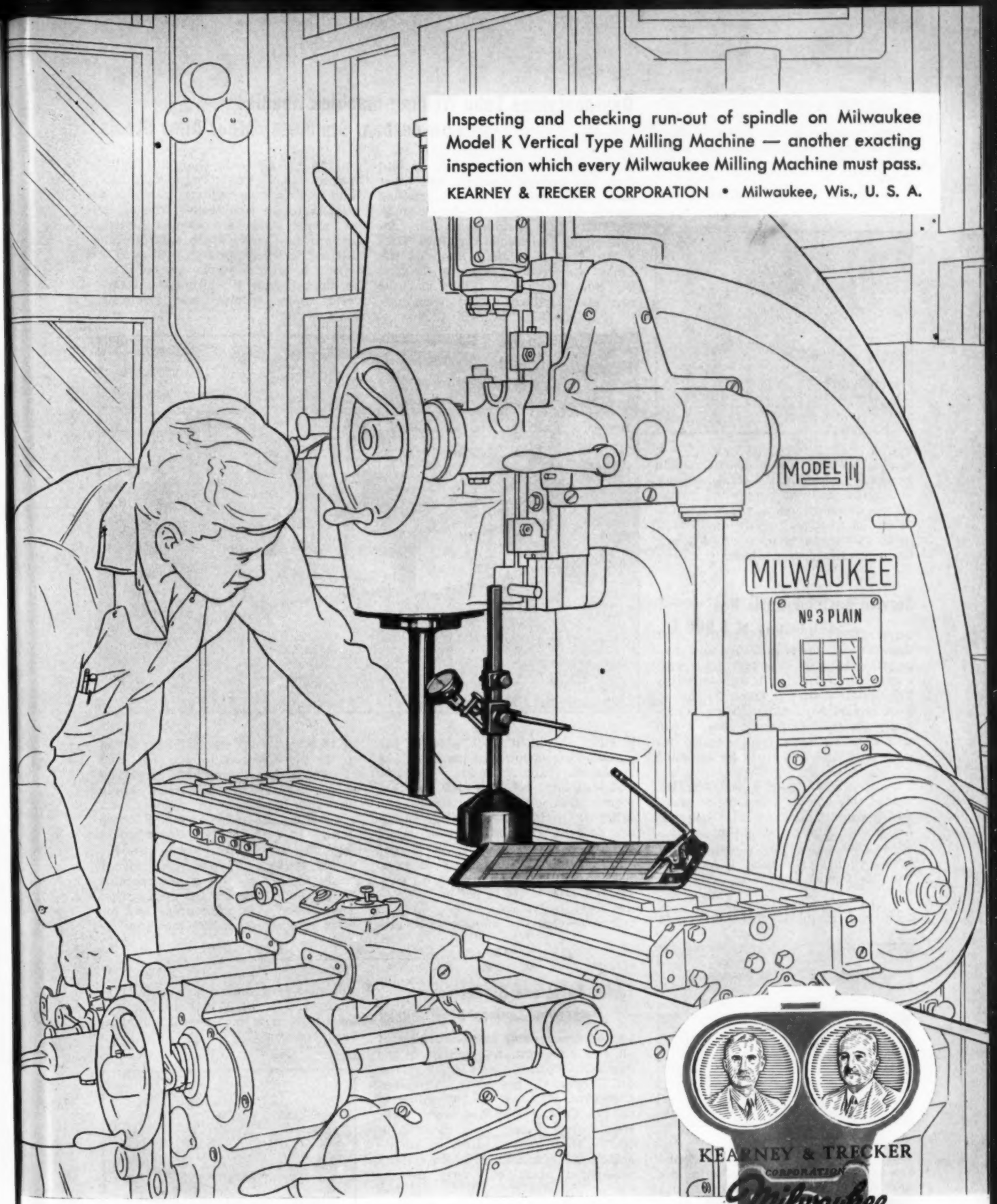
Capable of handling any size shafting between ¼ and 1¾ in., a series of six "Torflex" drive shaft couplings is being produced by Harris Products Company, 5416 Commonwealth Ave., Detroit, Mich. No pins, keys or screws are needed. Each coupling consists of two metal caps, two rubber bushings and a metal spacer. As the metal caps are screwed together, the rubber bushings are forced against the spacer with the result that they tighten on each shaft to furnish a slip-proof drive capable of transmitting torque. Only preparation necessary is the grooving of one shaft to a depth of $\frac{1}{16}$ in. These couplings will take parallel and angular misalignment. Distance between



shaft ends can range from ⅜ to 1½ in., depending on size of the coupling. To couple shafts of different diameters, the bore of one cap and bushing is enlarged to fit the larger shaft. By merely unscrewing the caps, couplings can be removed for inspection or replacement of bushings.

Sperry Industrial Shoes Have Non-Slip Rubber Soles

Adapting for industrial footwear a "squeegee" sole known as the "Sperry Top-Sider" originally developed for slippery decks, the Sperry Shoe Div. of the United States Rubber Co., announces a new line of non-slip footwear. "Top-Sider" footwear is available in oxfords, work rubbers, Terre Hautes, and short and long boots in white and black. The non-slip feature



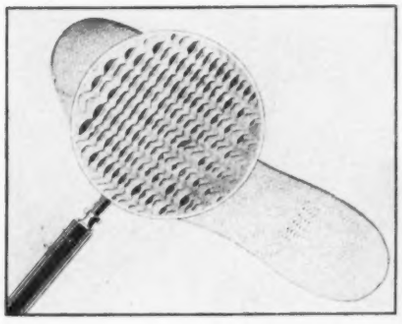
Inspecting and checking run-out of spindle on Milwaukee Model K Vertical Type Milling Machine — another exacting inspection which every Milwaukee Milling Machine must pass.

KEARNEY & TRECKER CORPORATION • Milwaukee, Wis., U. S. A.

Milwaukee MILLING MACHINES

of the sole makes it particularly advantageous for workmen in plating rooms, washing rooms, machine shops and in any other industrial job where there is danger of slipping on wet floors.

As shown in the illustration, the



sole is so constructed as to remain perfectly smooth on the straight-away, and being made of pure white rubber leaves no mark on any surface. In action on a slippery floor, hundreds of small rubber waves open up to create the suction-squeegee effect.

Service Caster Liftable Has Capacity of 5,000 Lb.

Capable of many material and tool handling tasks, a new Lift table with a capacity of 5,000 lb. is announced by The Service Caster & Truck Co., 635 N. Brownswood Ave., Albion, Mich. Originally designed to handle dies, it can also be used as a feeding table for press work and as a truck for handling storage batteries.

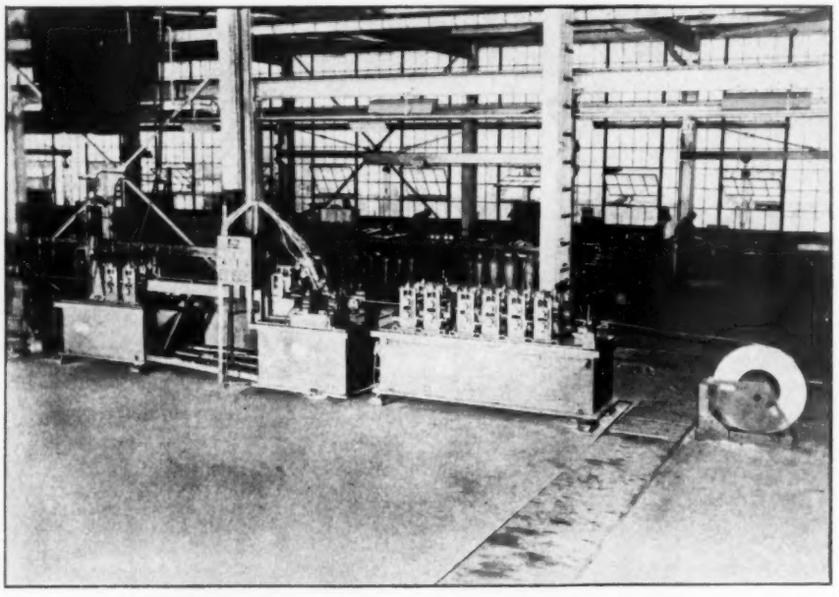
Construction is of steel, electric welded throughout. The table is raised and lowered by means of a vise-type handle. Lifting mechanism consists of a steel screw which actuates the lifting chains. The table is locked at working height by means of a cam lock.

Model shown is 4 ft. wide by 5 ft.

long. The top consists of a double row of rollers measuring 2½ in. dia. and running on sealed ball bearings. Height of table when extended is 36 in., and is 24 in. when lowered. All wheels are floor protective Textolites. Casters are pressure lubricated.

Oxy-acetylene Tube Welding Machine Handles Low-carbon, Stainless, Other Alloy Steels

Tubing can be continuously welded from low-carbon, stainless and other alloy steel skelp at high production speeds with a new automatic oxy-acetylene tube welding machine developed by the Yoder Co., 5500 Walworth Ave., Cleveland, Ohio and the Linde Air Products Co., 30 E. 42nd St., New York, N. Y. This machine can also produce tubing from un-



pickled, hot-rolled stock used in the manufacture of low-cost items such as automobile exhaust tubing, conduits, and structural tubing which does not require a smooth, polished finish.

Higher than usual welding speeds are claimed. For 14 B. w. g. skelp, the speed range is 30 to 100 ft. per min., for 16 B. w. g. skelp, it is 40 to 140 ft. per min., and for 18 B. w. g. skelp, it is 60 to 150 ft. per min. Welding speed for 20 gage skelp is held to 100 ft. per min. by limitations of mechanical facilities for handling lightweight skelp. The forming mill section of this tube welding machine is fed flat skelp from coils. The series of forming stands are powered through a worm-gear drive which assures even feeding at high speeds.

In the welding table section, heat is supplied from a multiple-flame Oxweld duplex welding head, requiring 25 to 30 percent less acetylene and 5 to 10 percent less oxygen per foot of weld than welding heads previously used. Separate oxy-acetylene supply lines are provided for welding and pre-heating flames. Supply of these gases is automatically controlled through regulators which provide steady working pressures. A conveniently located control panel contains adjustment regulators and push button controls for welding blowpipe and for drive mechanism of the machine.

Fewer Parts and Hardening Improves Keyless Drill Chucks

Use of fewer parts and hardening of all but one part has improved the durability of the "Knock Out" keyless drill chucks, previously described (*AM*—Vol. 81, page 340), according to the K. O. Lee Co., Aberdeen, S. D. Hands are the only tools required to operate these chucks, which are adaptable to portable as well as heavy-duty production machines. Grip permits use of ultimate strength of drill bits without slipping or damage. Accuracy is promoted by floating jaws and cone which provide permanent and positive alignment. Capacity of the six available sizes ranges from 0 to ¼ in., 0 to $\frac{5}{16}$ in., 0 to ⅜ in., $\frac{1}{16}$ to ½ in., $\frac{3}{16}$ to ⅝ in., and ¼ to ⅞ in. Sleeve is only non-hardened part.

It's hard to say "No" to a friend...

WE at Revere have always felt that we have, not "customers", but friends. Certainly, this has been our way of looking at it, because we have thought of your order not only as so many pounds or tons of metal—but as a valuable opportunity for us to make you feel glad you came to Revere for copper or copper alloys.

That's why we haven't had much use for the word "No"—up to the time of priorities and preference ratings. But Uncle Sam has the final word in this emergency, and now we sometimes find ourselves unable to oblige even our oldest and best friends.

Revere Technical Advisory Service will, however, continue to work closely with you, bringing to bear on your problems all of Revere's extensive knowledge of materials. In some cases we have been able to guide our customers into Defense contracts in which priorities work for them instead of tying their hands. So get in touch with Revere—together we may find a way of changing "No" to "Yes".

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Single Lever on New Landis 3/8-in. Threader Frees Operator's Hand for Loading, Unloading

Designed to rapidly and economically produce precision threads for use in aircraft and automotive industries, the new ⅜-in. threading machine brought out by Landis Machine Co., Waynesboro, Pa., is controlled by a single operating lever. Thus, the operator has complete freedom of one hand for loading and unloading work pieces. In operation the grips open at the end of the return stroke of the operating lever and automatically close during the first part of the forward stroke. Carriage advance is then controlled by continuation of the forward stroke until the end of the thread is reached. At that time the die head is automatically tripped open and is not closed until the return of the carriage. The operator, therefore, has the period from the closing of the grips until the return stroke to dispose of the finished piece and to select the next work piece. Only a light and uniform effort is required for the forward and return stroke of the operating lever.

Gripper unit consists of a spring loaded toggle mechanism, completely housed in the carriage. Interchangeable grips are used for the various work diameters within the capacity of the machine. These grippers are so designed that work pieces are loaded

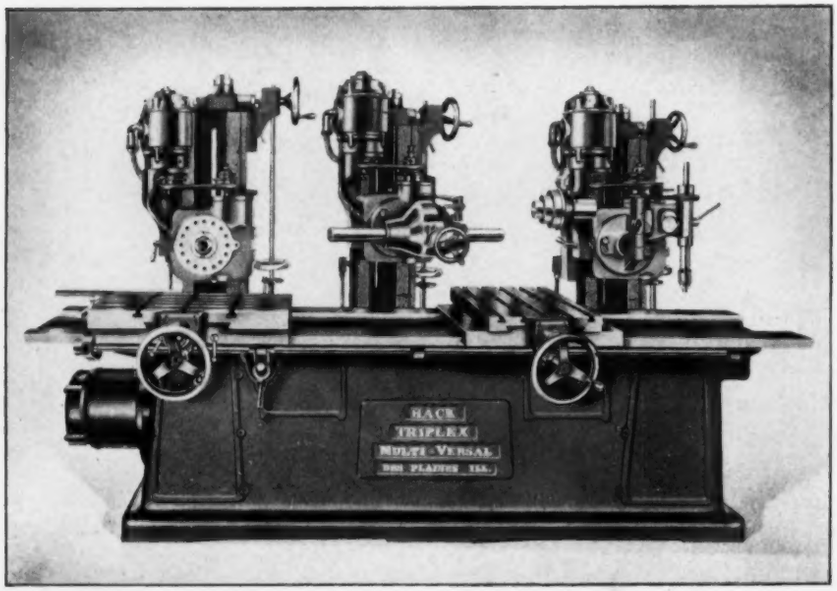
from the top of the grip, in contrast to the usual method of pushing pieces into the hole of a collet. Spindle of the machine is mounted precision preloaded ball bearings which are sealed against coolant and grit and lubricated from an oil reservoir in the spindle assembly. The spindle is driven through a single V-belt on sheaves of four steps, providing speeds of 270, 338, 520 and 845 r.p.m. Speed adjustments are facilitated by a single lever.

Hack's Multi-Versal Machines Perform Sequence of Operations

Designed to perform a sequence of operations without removal of work from the table, duplex and triplex "Multi-Versal" toolroom machines are being built by the Hack Machine Co., 1228 Harding Ave., Des Plaines, Ill. Vertical, angular and horizontal milling and jig boring, radial drilling, slotting and horizontal boring are some of the many operations claimed for the new machines. Both models have vernier scales in all directions.

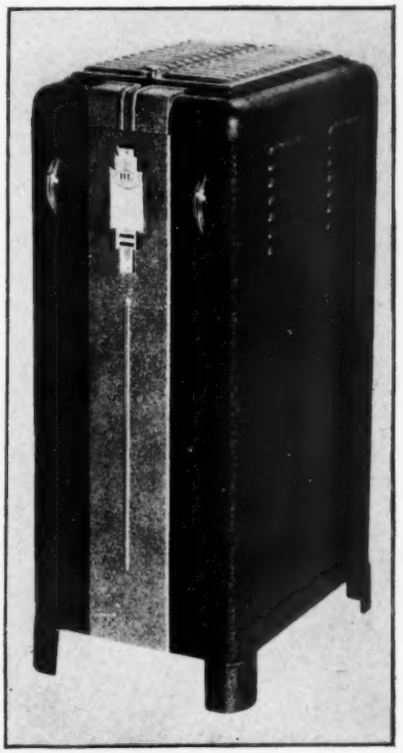
The Duplex model has a standard Multi-Versal column on the left and a 2½ in. horizontal boring bar in the right column. The boring bar, fitted with taper on both ends, will machine work on either right or left hand table. It has a travel of 18 in. and can be rotated 360 deg. to bore holes at any angle.

In addition, the Triplex model has a third column on the right, normally fitted with a radial drill head. Construction, however, permits use of any Multi-Versal attachment. The left hand Multi-Versal column has an adjustable reciprocating action, while the other two are stationary but interchangeable. Two different operations can be done at the same time. By straddling both tables, extremely long work can be machined.



Benwood Linze Makes Dry Plate Rectifiers for Electroplating

Compact, mobile dry plate rectifiers for electroplating have been designed by Benwood Linze Co., 1815 Locust St., St. Louis, Mo. Assembled in cabinets as complete units less controls, the rectifiers will serve individual tanks, or they can be grouped in parallel for heavy current loads and in series for high voltage needs. Control units are available which provide a variation in voltage from zero to 6 or 12 volts, the maximum of the units. Models are available in 300 and 500 amp. capacities at 6 and 12 volts. They operate from 230 and 440 volts, three phase, 60 cycle, A.C. supply circuits.



Shell Marker Reduces Rejections By Eliminating Great Pressures

Because each character is driven into the shell separately, the shell marking machine No. 2 of the M. E. Cunningham Co., 160 E. Carson St., Pittsburgh, Pa., eliminates the use of great pressure to obtain a deep, clear impression. Thus, a minimum of strain is exerted on the shell with a consequent de-

REMOVING 18 LBS. of nitrided steel IN 7 MINUTES

What's the P-Q* of your cutting tools?

Finning air-cooled airplane engine cylinders at the rate of 7 cylinders per hour . . . removing 18 lbs. of nitrided steel in 7 minutes — that's the performance record with SUNICUT. . . . A record that helps maintain the high P-Q* (production quota) set by this large airplane engine manufacturer with an "all-out" production schedule.

In the airplane industry, and in metal working industries of all kinds, SUNICUT is helping manufacturers maintain a higher P-Q* for their cutting tools. The excellent heat absorbing and wetting out properties of this modern transparent, sulphurized cutting oil makes possible increased speeds and feeds and improved finishes with precision.

On performance alone SUNICUT has won recognition. A test — in your own shop — may prove to be your first step toward making possible a higher P-Q.* Write to . . .

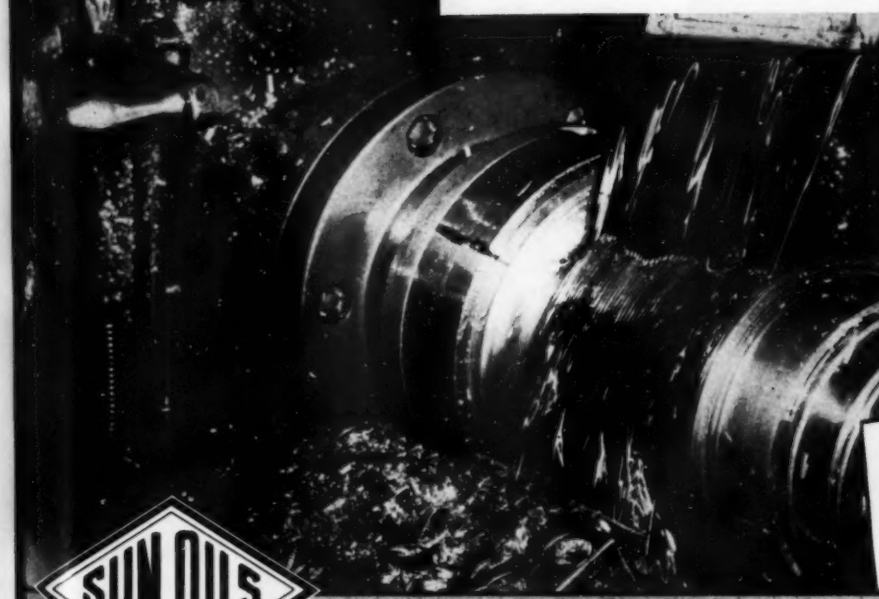
SUN OIL COMPANY, PHILADELPHIA, PA.

Sponsors of the Sunoco News Voice of the Air—Lowell Thomas

SUNICUT

NON-EMULSIFYING . . . TRANSPARENT

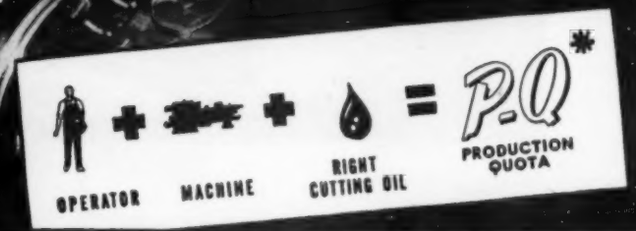
CUTTING OIL



PERFORMANCE DATA

OPERATION — Finning Air Cooled Airplane Engine Cylinder.
MACHINE — Jones & Lamson Heavy Duty 16" Fay Automatic Lathe.
MATERIAL — Nitrided Steel.
TOOLS — 47 H.S.S. tools in a single bank, removing 18 lbs. of metal in 7 minutes cutting time.
CUTTING LUBRICANT — Sunicut.

Photo Courtesy of
JONES & LAMSON MACHINE CO.



SUN OILS

PETROLEUM PRODUCTS FOR ALL INDUSTRIES

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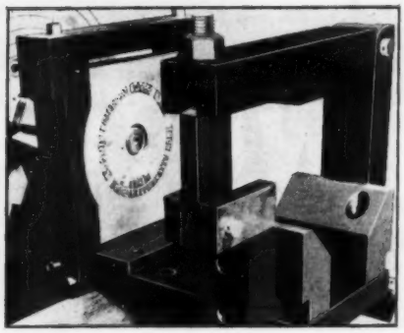


crease in rejections. This equipment can be furnished as a complete motor driven unit or as a fixture for setting up on a lathe. It can be made for any size shell.

Van Norman Adds Milling Machine For Small and Medium Size Parts

Developed for the production of small and medium size parts, Model No. 118 has been added to the line of milling machines manufactured by the Van Norman Machine Tool Co., Springfield, Mass. Bed type with hydraulic table feed, this machine has automatic table cycle and spindle stop. In addition to the normal cycle, skip stop cycles can be obtained by use of table dogs. Spindle stop feature automatically starts spindle when main operating lever is pulled and stops spindle when end of pass is reached.

Otherwise, spindle is operated by a clutch located in transmission. Belt adjustment to main drive pulley is aided by hinge mounting of the 3 hp. motor. Twelve spindle speed changes from 30 to 1,000 r.p.m. are made through pick-off gears. Spindle head slide, which is mounted on heavy box ways, can be raised or lowered by means of a large handwheel. Locking screws are provided for clamping head in place. General specifications are: longitudinal power feed, 18 in.; table feed ½ to 40 in. per min.; rapid traverse, 200 in. per min.; vertical movement of head slide, 7½ in.; minimum distance between table top and center of spindle, 2¾ in.; cross adjustment of quill, 3½ in.; working surface of table, 34 x 10 in.; floor space 65 x 46 in.; height, 61 in.; and weight, 3,600 lbs.

Standardized Drilling Elements Can Be Changed on "Holemaster"

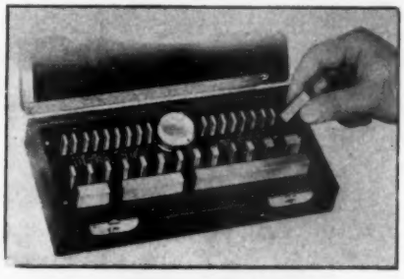
Two "Holemaster" machines, whose standardized elements can be changed and rearranged for most types of drilling and boring, have been developed by The Bradford Machine Tool Co., 657 Evans St., Cincinnati, Ohio. One model of single spindle type has a single motor for driving both spindle and hydraulic feed pump. The other model, which can be fitted with fixed center cluster box, and single spindle, multiple spindle and adjustable multiple spindle drill heads, has separate motors for drilling and feeding. Both models have interchangeable stationary and adjustable tables.

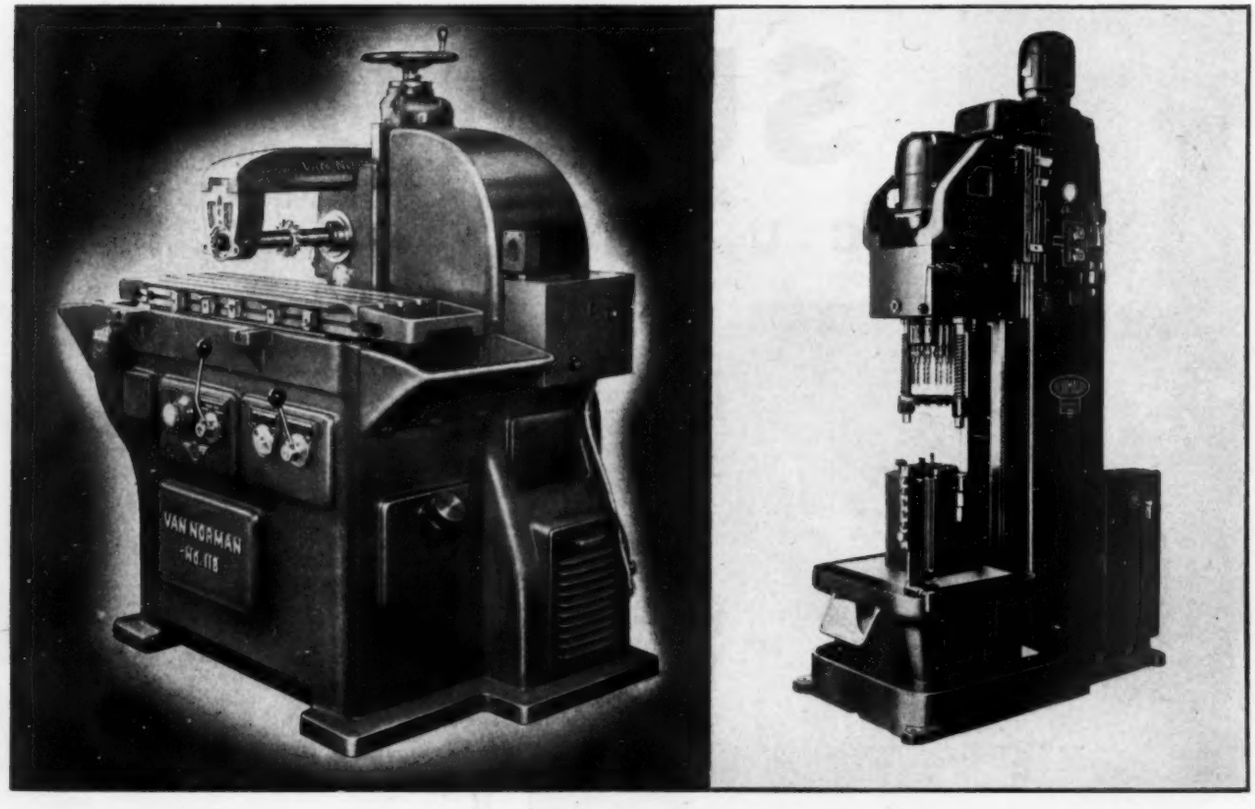
A jump feed attachment provides two feed cycles in addition to the standard cycle. A delayed reverse will cause a dwell at the end of feeding strokes for accurate facing in deep operations. Brackets at the right front side of the machine carry all push button controls. For set-up and emergency operation, there is an independent control. Electrical equipment is for use on 220 or 440 volts, 50 or 60 cycle, a.c. supply circuits.

George Scherr Announces Ultra-Chex Inspectoset

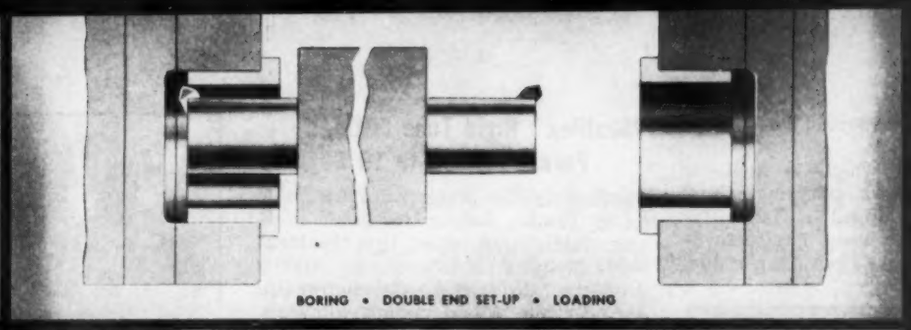
Consisting of 34 page blocks which will make up about 80,000 combinations in steps of 0.0001 in. from 0.300 in. to 8 in., the new Ultra-Chex Inspectoset has been added to the line of precision length standards of George Scherr Co., Inc., 128 Lafayette St., New York, N. Y.

There are nine blocks, in the One Ten Thousandth Series, ranging from 0.1001 to 0.1009 in. in steps of 0.0001 in.; nine blocks in the One Thousandth Series, ranging from 0.101 to 0.109 in.; nine blocks in the Ten Thousandth Series, ranging from 0.110 to 0.190 in.; four blocks in the One Hundred Thousandths Series, 0.100, 0.200, 0.300 and 0.500 in.; and three

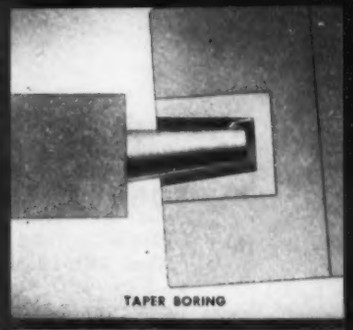




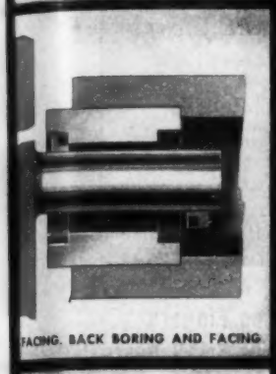
RECESSING



BORING • DOUBLE END SET-UP • LOADING



TAPER BORING

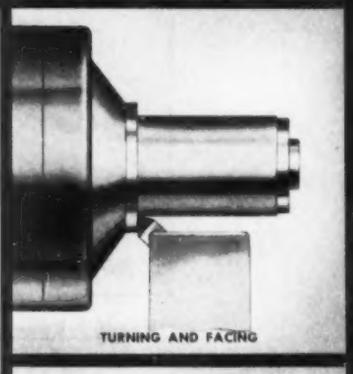


FACING, BACK BORING AND FACING

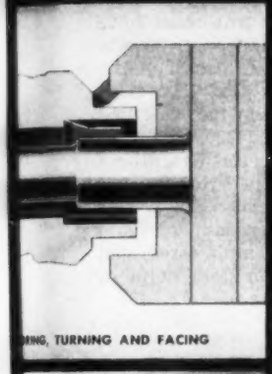
DESIGNED FOR MANY JOBS!

Ex-Cell-O Standard Boring Machines Perform Numerous Operations . . . Simultaneously

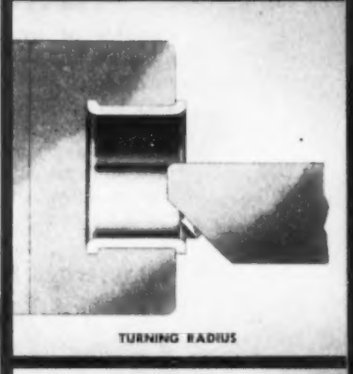
Illustrated here is a combined operation on an Ex-Cell-O Precision Boring Machine (Style 1212-A —Junior Double End) with an Ex-Cell-O Universal Fixture. Job is boring, facing, turning and chamfering brass aircraft gyro part with extremely close tolerances and on a production basis. Inspection has been minimized and other costs substantially reduced.



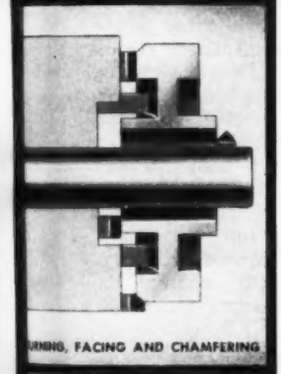
TURNING AND FACING



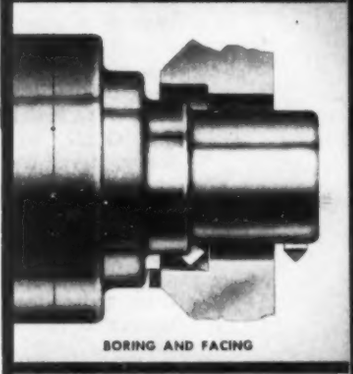
ING, TURNING AND FACING



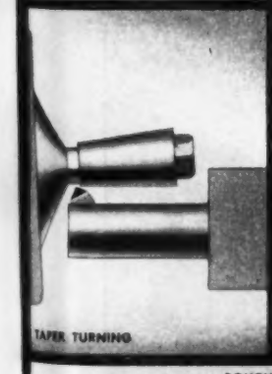
TURNING RADIUS



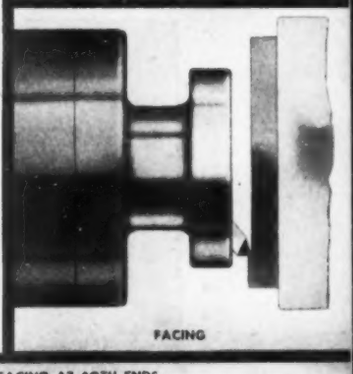
NING, FACING AND CHAMFERING



BORING AND FACING



TAPER TURNING

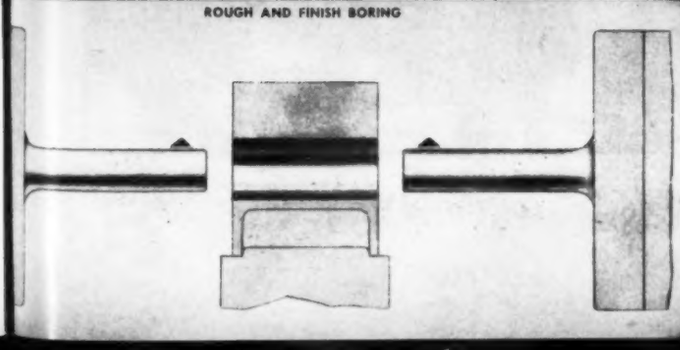


FACING

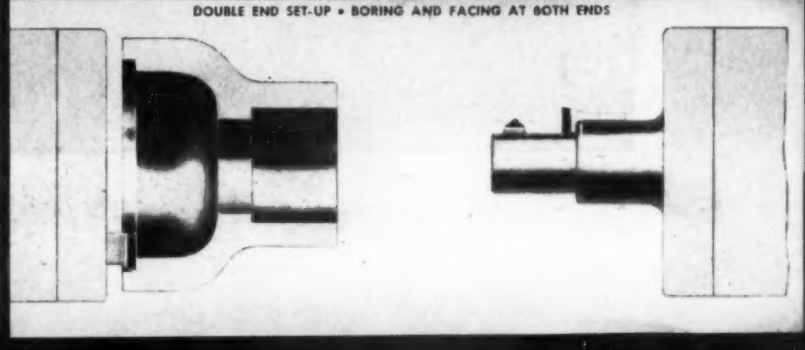
IN MACHINING interchangeable parts, there are varied possibilities to an Ex-Cell-O Precision Boring Machine. Not only will it rough and finish bore holes—straight, taper, blind, interrupted—but it will also turn, face, chamfer, groove, with almost any combination accomplished at the one time. Some of these single and combined operations are indicated by the surrounding sketches. And every Ex-Cell-O Boring Machine is a *Precision* Machine, with exclusive Ex-Cell-O features of design and construction that assure the greatest production of uniform work to the closest possible limits in size and finish. These Ex-Cell-O Precision Boring Machines (there are five standard styles) are enabling many manufacturers to meet successfully the unparalleled demand for defense items.

EX-CELL-O CORPORATION • DETROIT, MICH.

EX-CELL-O (XLO) *Precision* **MACHINES AND TOOLS**



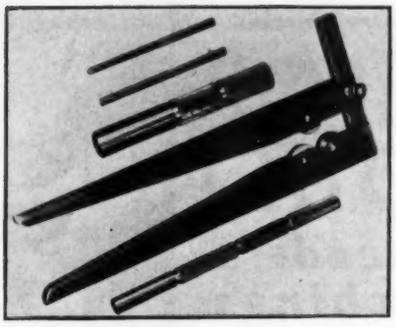
ROUGH AND FINISH BORING



DOUBLE END SET-UP • BORING AND FACING AT BOTH ENDS

blocks in the Inch Series, 1.000, 2.000, and 4.000 in.

An optical flat which is used for checking gage blocks, micrometer anvils and other lapped surfaces for parallelism and planeness is also furnished with the Ultra-Chex Inspectoset.



"Handy" Knurler Can Be Used On 5/16 to 2 In. Diameters

Capable of knurling diameters from $\frac{5}{16}$ to 2 in., the "handy" knurler announced by Pacific Specialty Supply Co., 344 N. Vermont Ave., Los Angeles, Calif., operates like a pair of pliers. A time saver, its free knurls are compressed against the work by pressing the handles.

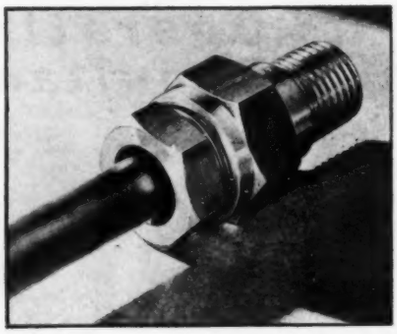
Conveyorized Salt Bath Furnace Maintains Constant Temperatures

A completely conveyorized electric salt bath furnace for case hardening, simultaneous brazing and carburizing, tempering, annealing, brazing, and heating for forging, has been developed by the Ajax Electric Co., Frankford Ave. and Allen St., Philadelphia, Pa. Guided by an overhead conveyor screw, parts travel through the bath at a controlled speed. Temperatures from 300 to 2,400 degrees are maintained virtually constant for the duration of the heat-treating period. A slotted cover keeps down heat loss from radiation. Heating of the bath is such as to cause continuous stirring.

"Sealflex" Rigid Tube Fittings Permit Flexing to 10 Degrees

Eliminating the necessity of installing costly flexible tubing for high pressure fluid transmission, the "Sealflex" tube fittings, introduced by Harris Products Co., 5416 Commonwealth Ave., Detroit, Mich., permit vibratory flexing of rigid tubes to 10 deg. included angle. High pressure and flexibility results from the use of a gasket-like rubber or synthetic insulator holding a ferrule.

The ferrule is rolled in on the tube and prevents slipping or swedging down the end of the tube. Supplied in all standard sizes and threads these fittings are quickly assembled without special tools. No flaring is necessary, and only a few turns of a ferrule rolling tool, an adaptation of a tube cutter, are needed to secure ferrule.



Fingerless Gloves Free Fingers For Fast Handling of Small Parts

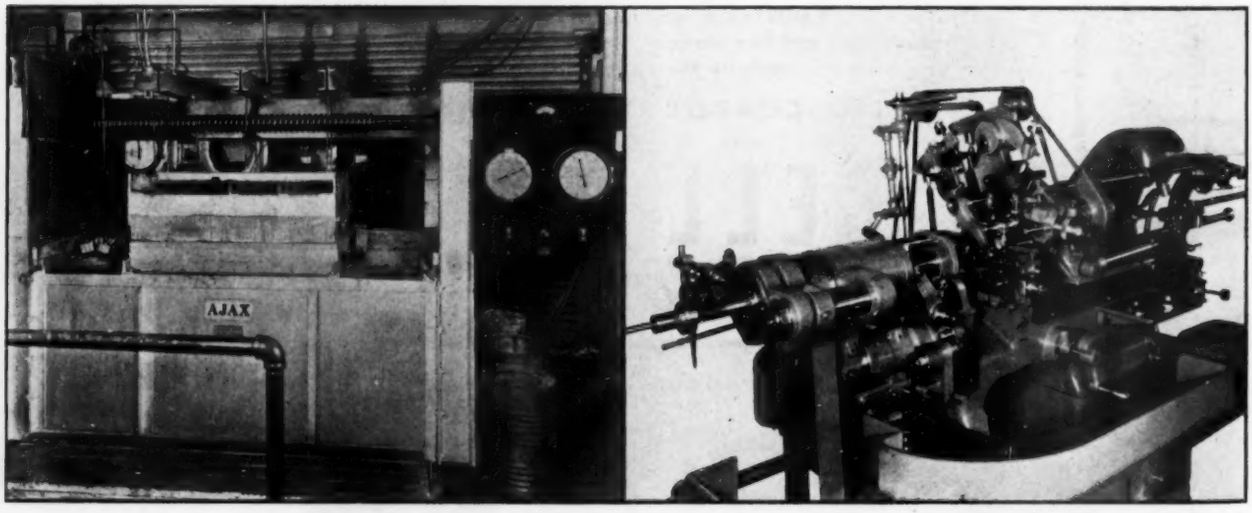
For machine operators who must have complete freedom of fingers to quickly handle thin sheets and small parts, the Industrial Gloves Co., 721 Garfield Blvd., Danville, Ill., has designed a fingerless glove, No. 14330. Made of chrome tanned, split leathers, these gloves are steel stitched to prevent ripping. They are claimed to give thorough protection for palm of hand and between thumb and forefinger. Gloves can be worn on bare hand or over light weight glove.

American-Made Swiss Type Screw Machine Introduced by Triplex

Because imports are shut off by the war, a Swiss type automatic screw machine of American manufacture has been introduced by Triplex Machine Tool Co., 125 Barclay St., New York, N. Y. The machine, which has a round stock capacity of $\frac{3}{8}$ in., will turn pieces $1\frac{1}{2}$ in. long with a flat feed cam or $2\frac{3}{4}$ in. long with a bell cam.

Stock, fed through a guide bushing is acted on by radially disposed tools. The four toolslides for turning, forming and cutting are immediately ahead of the guide bushing so that overhang at the cutting point is small. It is claimed that this guarantees accuracy regardless of the turning length.

An attachment is provided which swings three cutter spindles in line with the work axis for spot centering, drilling, and right-hand threading. A single right-hand threading device also is available. This machine is motor driven with speeds up to 6,100 r.p.m.



Sherwin-Williams Enamel Speeds Machine Tool Finishing

Known as Kem machine tool enamel, a new finish announced by Sherwin-Williams Co., Cleveland, Ohio, is said to cut many hours and even days from the finishing time formerly required on large machine tools, and is said to have far greater resistance to cutting compounds. The new synthetic enamel is expected to be of great interest to manufacturers who are not set up for lacquer work, or who need a more resistant finish.

Compared with the oil enamel method, which may require from a day and a half to four days, the new Kem finishes can be applied in 5¾ to 8½ hr., four coats, thus permitting the work to be shipped the same day it is finished and assembled. A typical drying schedule is as follows:

Spray or Brush coat	
Zinc Chromate Primer	15 to 30 min.
Machine Filler.....	4 to 5 hr.
Kem Sealer Gray.....	15 to 30 min.
Kem Machine Tool Gray	15 to 30 min.
Dry and crated.....	1 to 2 hr.
Total	5¾ to 8½ hr.

Wm. Klemp Offers Steel Grating For Inside or Outside Use

A welded steel grating of one piece construction, available in panels 24 in. wide and up to 35 ft. in length, is offered by the Wm. F. Klemp Co., 6601 S. Melvina Ave., Chicago, Ill. The nonslip, self-cleaning surface, it is said, is suitable for inside and outside passage ways, platforms, ramps, stair treads, and coverings for flow-ways. This grating is made by placing hot rolled hexagonal steel bars at right angles on top of flat bearing bars set on edge. Electro-welded under pressure, the cross rods sink flush into the bearing bars, resulting in a one piece construction.

TRADE PUBLICATIONS

BEARINGS A new catalog, circulated by Keystone Carbon Co., St. Marys, Pa., describes and illustrates the properties and uses of self-lubricating bearings and furnishes complete details on the correct method of installation.

BELT LACING Bulletin No. 731 describing steel belt lacing for joining or repairing machine and conveyor belts has just been released by the Mill Supply Div., the Bristol Co., Waterbury, Conn. Information is given on typical applications, types and sizes available, as well as prices.

ELECTRIC DRILLS Independent Pneumatic Tool Co., Chicago, Ill., is circulating a new six-page bulletin, No. JE-112, showing the latest ¼-in. capacity, one-hand electric drills. The

(Advertisement)

Manufacturers Look to Steel Warehouses for Quick Defense Requirements

Many leading manufacturers are relying on nearby steel-service plants for prompt, stock shipment of steel to meet the current surge of business prompted by our National Defense Program.

Probably the leading exponent of "Immediate Steel" is Joseph T. Ryerson & Son, Inc., with their net work of ten strategically-located plants, each of which is completely equipped for prompt service on steel and allied products, formed and cut to customers' exact requirements. No shop should be without the Ryerson Stock List (see advertisement below).

Thousands of manufacturers report saving considerable time, trouble and money by taking advantage of Ryerson's complete flame cutting service. Modern equipment manned by specially trained operators can quickly burn any shape—no matter how intricate—from carbon or alloy steel plates and billets up to 15" thick.

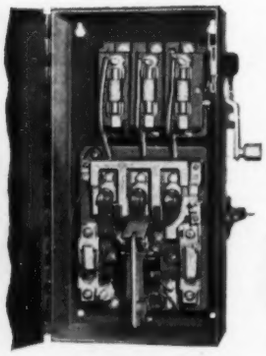
99 YEARS
●Ninety-nine years means very little! Ninety-nine years of highly specialized experience in the steel business means a great deal; especially when that experience has involved handling huge quantities of steel, in thousands of kinds, shapes and sizes, and serving the varied needs of a host of users in every industry.
Ryerson can and does pledge that all of the skill and experience gained through 99 years of successful operation, always will vigorously be devoted to the interests of Ryerson customers. In the present period of steel shortage—as in similar periods in the past—the Ryerson organization is bending every effort to meet as nearly as possible every demand being made upon it. Later when American industry is back to normal production, the same organization will be working just as hard to provide steels of highest quality to meet every customer's requirement, and to provide them on the immediate basis which is synonymous with the name Ryerson.
We are glad to be 99! We are grateful for the past loyalty of our customers—but more grateful, perhaps, for their cooperation now, in our effort to serve them to the full limit of our resources. Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.
RYERSON

Joe...the employees in your new plant will be safer with G-E combination starters

"We've found that we can place these starters next to a machine without fear of operator's tampering with box while machine is in operation."*

**Statement by Raymond Dingler, chief electrician, Monolith Portland Midwest Co., Laramie, Wyoming*

Safer than Separate Devices in 3 Ways—



SAFER because the fused manual circuit switch is ***selected*** for use with your motor—no danger from interrupting heavy overcurrents in an emergency.

SAFER because the cover ***can't*** be opened as long as the circuit switch is closed and power is applied to the starter and the machine.

SAFER because ***as long as the cover remains open*** the line switch cannot be accidentally closed, applying power to the parts being inspected.

GENERAL ELECTRIC

o7n-44-8496

circular contains specifications on portable electric drills for every industrial application. A complete range of models, motor sizes, speeds and switch styles are described.

FLEXIBLE BEARINGS Harris Products Co., Detroit, Mich. has just issued an eight-page folder containing general engineering data, including operating characteristics for various standard size flexible bearings. Information on radial loads, radial and axial deflection, and rubber wall thicknesses of stock sizes available is provided.

GEAR MATERIALS Synthane Corp., Oaks, Pa., is circulating a new folder which illustrates and describes materials for silent stablized gears.

LATHES The South Bend Lathe Co., South Bend, Ind., has just published its folder No. 69-E describing its line of back-geared screw-cutting precision lathes. The folder includes specifications for the lathes, as well as attachments and accessories available.

RUST REMOVERS Oakite Products, Inc., New York, N. Y. is circulating an illustrated 20-page booklet which provides concise data on Oakite Compound No. 32, the cleaning agent which quickly removes water scales, rust and similar deposits from over 29 different types of water-cooled or water-circulating processing and other equipment.

SMALL TOOLS Brown & Sharpe Mfg. Co., Providence, R. I., has issued a new 512-page catalog, No. 34, which lists a complete line of machinists' precision tools, milling cutters, hobs, arbors, adapters and collets, screw machine tools and pumps.

SOCKET SCREWS Bristol setscrews, capscrews with knurled and plain heads, several types of wrenches, and stripper bolts with multiple spline and/or hexagonal sockets are described in catalog 846a just published by the Mill Supply Div. of the Bristol Co., Waterbury, Conn. Specification details, prices, size and material, and heat-treating data of Bristol socket-screw products are given. The use of multiple spline sockets for all sizes of setscrews and capscrews, especially in wire sizes, is discussed.

SPRAY EQUIPMENT The DeVilbiss Co., Toledo, Ohio, has issued a new catalog covering in condensed form its complete line of standard spray-finishing equipment for industrial use. The catalog, called "IE" replaces "ID-A" and brings all prices and specifications of the company's line up to date.

TRANSFORMERS A four-page bulletin, No. TU-34, recently published by Wagner Electric Corp., St. Louis, Mo., describes a new type of transformer which has integral protection against surges and overload.

NEW BOOKS

PRINCIPLES AND PRACTICE OF HEAT-TREATMENT—*By J. Winning, Dipl. R.T.C. Published in Great Britain. Ninety-nine pages. Emmott & Company Ltd., 31 King Street West, Manchester 3, England. Price 2/ net.*

In his preface to this practical discussion of modern heat-treatment methods, the author says in part "The writer is strongly of the opinion that a thorough grasp of essential theoretical points is imperative to an intelligent practical application in all heat-treatment, and for that reason has given this side of the subject at least as much prominence as the practical." He has, we believe, succeeded well in his attempt to give a concise and rational account of modern heat-treatment methods and the principles on which they are based.

In addition to discussing basic principles and their applications in practical heat-treatment operations, the author describes practically all of the modern types of heat-treating equipment, including oxyacetylene surface hardening machines and Tocco equipment for induction hardening. While most of the discussion is given over to the heat-treatment of various steels and other ferrous alloys, one chapter is devoted to a discussion of the treatment of several of the non-ferrous alloys, including brass and aluminum alloys. In the final chapter, the author makes some practical suggestions regarding the planning of a heat-treatment procedure.

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AIRCRAFT ENGINE TROUBLE CHART—*Arranged by Lt. Col. Victor W. Page, U. S. Air Reserve. Single-page 25x38-in. chart. Published by The Norman W. Henley Publishing Company, 17 West 45th St., New York, N. Y. 50 cents.*

This wall chart shows an enlarged sectional view of a typical modern single-row air-cooled radial engine. References are given to engine parts and there is a summary of causes of noisy operation, misfiring, loss of power, overheating, and irregular operation due to troubles in the engine mechanism. Brief suggestions are given for repairs. The chart is a comprehensive summary of the common derangements that interfere with smooth running and steady power output of radial aircraft engines.

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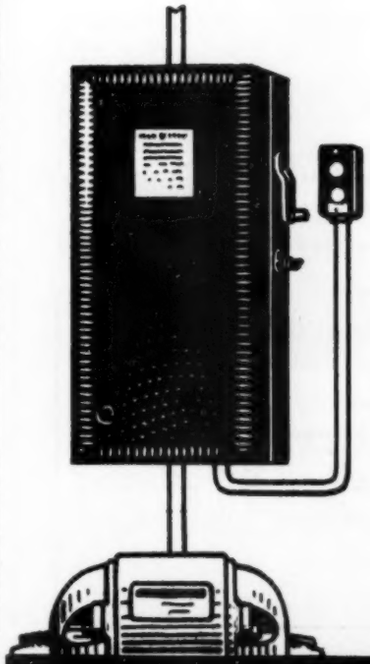
MILLING PRACTICE—*Compiled by E. Molloy. 104 pages. Published by Chemical Publishing Company, 234 King St., Brooklyn, N. Y. $2.00.*

This book is intended as a practical guide for milling machine operators in the production shop and toolroom. A portion of the book is devoted to a

"Our experience shows that it takes less labor to install G-E combination starters than to put in separate devices. And they save on conduit."*

**Statement by Walter B. Atchinson, electrical engineer of a large valve plant*



Here's all an electrician needs to do to install a G-E combination starter

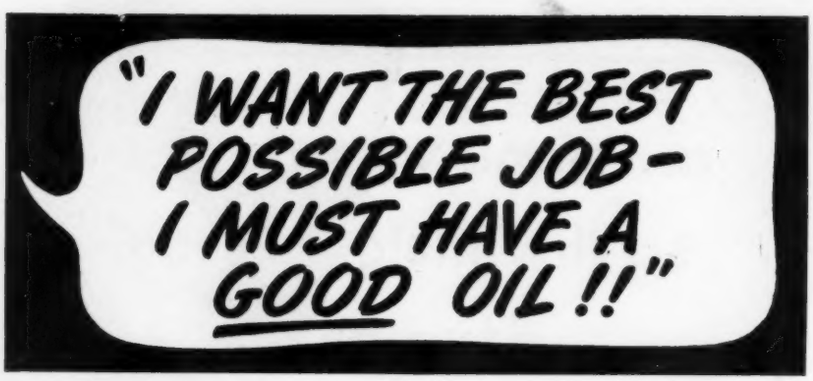
A. Mount one compact starter (not two devices).

B. Run conduit and pull wires to motor, push-button, and power supply.

C. Make 9 quick connections (not 15) in starter, insert fuses, and—motor is ready to run.

Send for "More for Your Control Dollar" (GES-2456). General Electric, Sec. 676-44, Schenectady, N. Y.

GENERAL ELECTRIC



"THAT'S WHY I CALLED THE CITIES SERVICE LUBRICATION MAN IN" SAYS A. E. DAVEY, PRESIDENT OF ALLOY STEEL GEAR AND PINION COMPANY OF CHICAGO.

"I'm doing a job here that must be perfect when it leaves the shop. The people who get the gears are plenty critical." These are the words of A. E. Davey, president of the Alloy Steel Gear and Pinion Company.

He says further, "I don't know everything about oil. That is why I called in the Cities Service Lubrication man. I expect him to work with my men to see that they get the lubricant best suited for the job."

A. E. Davey

Much work in this shop must meet rigid government inspection. All machines, including Gleason, Fellows Gear Shapers, Lee Bradner and Browne & Sharpe machines, are operated with Cities Service Lubricants. You, too, will find these high-quality fluids capable of doing the kind of work your customers want.

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general milling practice, giving typical set-ups for various jobs on all types of milling machines, and recommended types of cutters for the work. Instructions are given for the use of the dividing head in cutting spur gears, bevel gears, spiral flutes in reamers and taps, and cams.

Data are also given on die milling, with special reference to the manufacture and use of molds, dies and tools used in the plastics and die-casting industries.

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GEARS AND GEAR-CUTTING—*Edited by F. J. Camm, Editor, Practical Engineering. Published in Great Britain. 144 pages. Chemical Publishing Company, 234 King St., Brooklyn, N. Y. $2.00.*

Including a series of articles on gear cutting contributed to *Practical Engineering* by W. A. Tuplin, this practical discussion of current English practice includes a brief description of the various types of gears in current use, and of the methods employed for generating these gears. An entire chapter is given over to a discussion of various methods employed for measuring gears and gear teeth, while another chapter describes the manufacture of hobs, end mills and generating cutters. More than one hundred illustrations are employed throughout the book to show the more important points in the discussion. Of especial value is a well illustrated chapter on useful formulas for gears. This chapter also gives data for the calculation of chain sprockets.

TO THE EDITOR

Young at 43

Dear Sir:

For the past several years we have been faced with a possible shortage of skilled men. Particularly, good all-round machinists and toolmakers. Coincidentally industry has suffered from an idiotic hallucination known as "age limit for hiring men." Because industry would not hire men over a certain age, many expert machinists have sold their tools in disgust and gradually eased themselves into a more profitable business such as selling hot dogs or relaxing in absolute comfort at the government's expense.

About five years ago an announcement at a union meeting was made to the effect that machinists with all-round experience were needed—but they must not be over 43 years old! It is almost universally agreed that a Supreme Court Justice is a youth at 70 and develops wisdom as he matures. A machinist at 43 should be regarded as a young man, one who has developed and will develop more skill with continued experience. A mechanic who has been through the mill, who is able

to master difficult situations, and who is not easily affected by trouble-makers, should be considered invaluable! Lets stop chucking these men out.

Sincerely,
J. HOMEWOOD

EDITOR'S NOTE: *Companies that discriminate against men over 40 are few and far between. Most plants welcome good experienced men; many give them preference over youngsters.*

Plating for Defense

We are likely to think of defense work as being confined to the making of shells, guns, airplanes and other munitions. But a little scouting around among industries that seem to have little or no connection with war material gives us a different picture.

Makers of electroplating apparatus for example are supplying equipment for cadmium plating torpedoes, airplane parts and other war appliances where rust must be prevented. A process has been developed for building up parts that are too small with heavy coatings of nickel plate, without the usual copper plate underneath. These coatings are heavy enough to permit machining to size after plating. Certain steel forged parts must be brass plated to provide a base for vulcanizing rubber pads. There are many other uses of electroplating apparatus that we are likely to think of as being just for fancy finishes.

Plan-Changing Department

By JOHN R. GODFREY

"I hear you've got a new planning department, Bill", said Old Man Johnson to his friend Bill Kershaw not long ago.

"That's new to me, Tom. I hadn't heard of it."

"Well Bill, it probably isn't official, if that's what you mean. But you've got it whether you know it or not."

"I suppose you've been having some more trouble with our P.A.—or is it the engineers this time?"

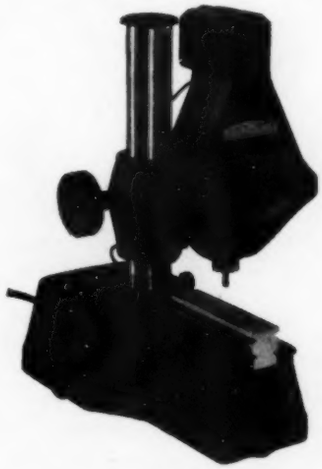
"Engineers, Bill. I wish you'd put some glue in their chairs so they'd stay put until we get an order started at least. We can't even get going before someone from your engineering office in Kalamazoo hops to the telephone and tells us to hold everything, he's had a new brain storm. I'll bet your telephone bill would come darn near paying a dividend, Bill."

"That's an idea, too, Tom. But tell me what's the trouble?"

"Trouble enough, Bill. We get requests from your engineers to make up a special valve for your next year's sausage stuffer—at least that's what our boys call it. So we go into a huddle and design something to do the trick. Our man shows it to your engineering staff and gets his O.K. He wires us to go ahead because you

The attention of industry is being called emphatically to the urgent need for accurate and rapid inspection at tolerances never before encountered in a period of rapidly expanding production.

In order to handle this tremendous volume of gaging operations with the highest degree of precision, gages such as the Sheffield Visual Gage are absolutely essential. The Visual Gage is highly sensitive, instantaneous in its action and deadly accurate (checking to thousandths, "tenths" and millionths of an inch). It is used for checking dimensions of manufactured and purchased parts, tools, production and master gages.



At the same time it is very simple in construction, can be handled easily by anyone familiar with inspection work, and is extremely durable.

The Reed Mechanism (the heart of the Visual Gage) is positive in action and entirely free from the limitations of frictional wear. It contains no gears, knife edges or rubbing contacts—nothing to wear out of adjustment. Measurements by the Visual Gage are always consistent and thoroughly reliable. It is one of the most efficient instruments available to inspection.

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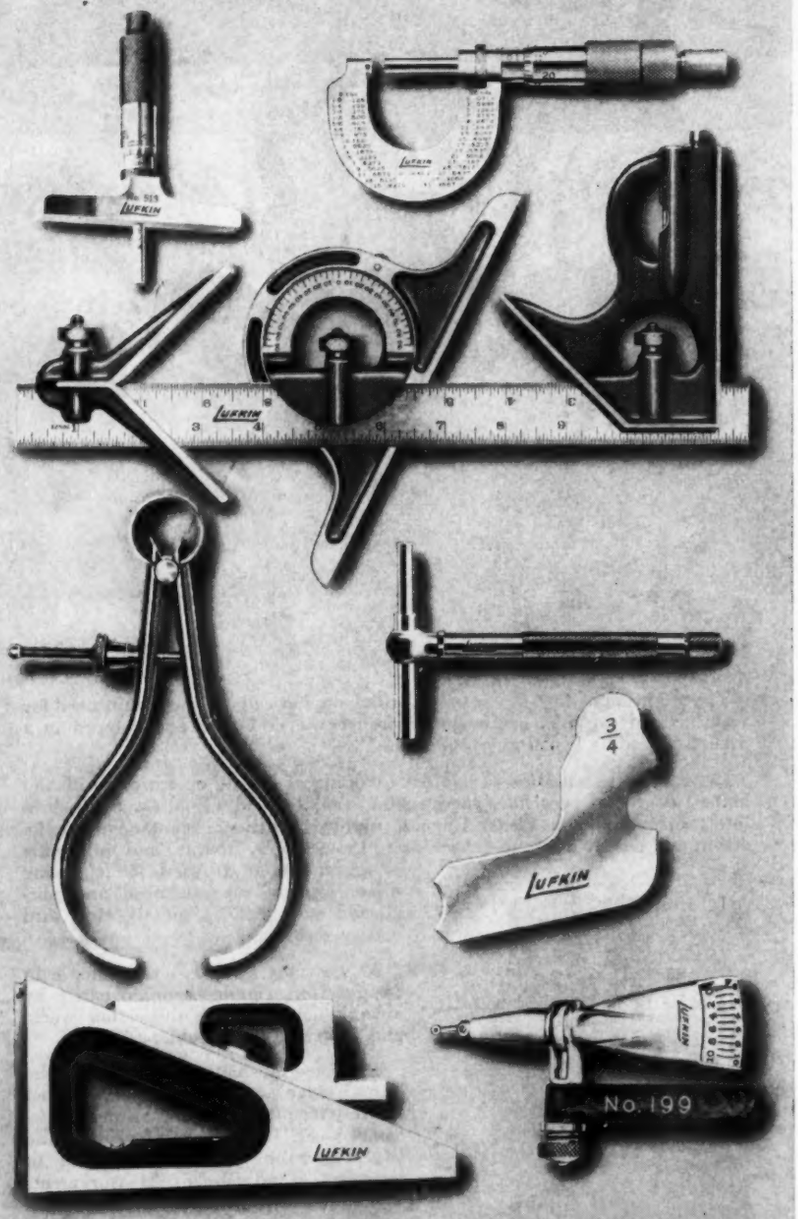

There's something about Lufkin Precision Tools that appeals to mechanics who take real pride in their work. Perhaps it has its roots in the downright good workmanship that's put into them in the first place. At any rate—it isn't hard to find—and your dealer will be glad to show you.

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always wait till the last gun. We order the castings and get all tooled up for the job—and then your new department gets busy."

"What new department?"

"Our boys call it the plan-changing department—sort of a supreme court that tells your engineers where to get off. And whether you know it or not, Bill, that department works overtime and costs you plenty."

"Will that delay our order, Tom?"

"How can it help it? We've got to change the patterns, throw away all castings we've made; change the tooling and wait for new castings."

"And do we pay for these changes, Tom?"

"Another foolish question, Bill. Do you suppose *we* pay for them? They won't show on the bill, but you'll pay for them just the same. We have to count on these when we make our price. The bidder who don't know about your plan-changing department is just out of luck, Bill—he'll lose his shirt."

"Sounds as though you aren't very keen about our business, Tom. I thought we were a pretty good customer."

"Sure we want your business, Bill. I'm just trying to show you how you are spending a lot of money that doesn't get you anywhere. In fact it keeps some good concerns I know from even bidding on your work."

"Well, Tom, what's the answer?"

"That's your job, Bill. But if it was my crowd I'd make some good man a sort of dictator and what he said would stick. I'd give everyone a chance to put in his ideas. But when the engineers once made up their minds as to a design it wouldn't be changed after work had started. Your planning department may be O.K.—but your plan-changing gang costs you a lot of money."

Leak Detection

By H. A. BOLZ

Where small copper-brazed parts like float balls are to be tested for leakage, the common method of immersing the parts in a clear fluid contained in a glass vessel and subjecting the air in the vessel above the fluid to a vacuum in order to disclose any leaks in the braze is expensive and slow. Since the size of a leak in an all-metal body is unaffected by the magnitude of the pressure differential on the two sides of the leak, only a small pressure difference is required to locate such a leak. This may be accomplished in a rapid and inexpensive way by merely immersing the part in a container of kerosene or other light, transparent oil that has been heated somewhat above room temperature; 115° F. will suffice and is comfortable to the hands. The expansion of the entrapped air will cause bubbles to rise almost immediately from any pores that may exist in the braze.